AN ECONOMIC ANALYSIS OF THE RESPONSE OF POLISH AGRICULTURE TO POLAND'S ECONOMIC TRANSITION TO A FREE MARKET ECONOMY

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This thesis analyses the economic response of the Polish agricultural sector to the post 1989 political and economic reforms. The research adopts a two tiered spatial structure that utilises the Polish economic response from both the national and regional perspectives. At the national level, the overriding concern is the economic performance of the Polish farming sector and its affiliated industries during the country's transition from a centrally planned to a more market-orientated economy. The thesis includes an evaluation of a number of inter-related variables including ownership rights, the role of research, technology and development, the availability of private and public sources of investment and rural infrastructure, the implications of current EU-Poland trade agreements and increasing trade competitiveness.

The centrepiece of this research is an econometric analysis of Poland's primary sector using the Cobb Douglas production function. In short, the model is a production-based, supply-side analysis of the relationship between agricultural output and inputs, evaluating econometrically the determinants of Polish national and regional arable supply (1989-1993). The empirical component of the research programme uses published and unpublished Polish secondary agricultural and meteorological data; interview material gathered from European Union officials, Polish central and local government representatives, academics,farmers and state sector managers. Localised information gathered in two study areas in Poland during 1993 and 1994 provides further useful insights into the local impact of economic reforms.

These theoretical and empirical inputs allow a two tier analysis of the response of Polish farming to the transition process. The first focuses upon issues surrounding economic transition and its future implications for Polish agricultural production. The second considers the general role of the primary sector in socio-economic development. This empirical research, therefore, synthesises various aspects of agricultural development theory within the present climate of Central and Eastern European economic change.

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CHRONOLOGY

1795-1918	PERIOD OF THE PARTITIONS
1918	Allied Governments recognise principle of Polish Independence
1918-1945	PERIOD OF INDEPENDENCE
28 September 1939	Poland partitioned by Germany and USSR
1944-5	Liberation: complete occupation of Polish lands by Soviet Army
1944-1989	PEOPLE'S POLAND
1948	Formation of Polish United Workers' Party: One-Party State launched
1956-1989	Poland governed by national communist regime
1980	Birth of 'Solidarity' and 'Rural Solidarity'
1987	'Perestroika' and 'Glasnost'
4 June 1989	Free elections are held. Solidarity tips the balance of power against the communists and the first non-communist government is elected in Poland
6 June 1989	Jaruzelski, leader of the communist government invites Solidarity to form a coalition government but it declines
30 June 1989	The government adopts provisions for an economic programme for 1989/92 suggested by the IMF and World Bank
19 July 1989	The National Assembly elects Wojciech Jaruzelski as president of Poland
1 August 1989	Agricultural price liberalisation
19 August 1989	Mazowiecki, the first non-communist Prime Minister replaces Kiszcak after his resignation
6 October 1989	Poland's new government announces plans for a market economy
December 1989	PHARE launched
1 January 1990	Stabilisation Programme begins under Leszek Balcerowicz, Finance Minister
25 January 1990	The Polish United Worker's Party is officially dissolved. A new party, the Democracy of the Republic of Poland is formed

22 December 1990	Walesa takes the oath as president
29 December 1990	Jan Bielecki is appointed as Prime Minister. He promises to continue the reforms begun under Mazowiecki's administration
19 October 1991	Act on the Management of the agricultural realty of the State Treasury 31 December 1991 Association Agreement between Poland and the EC
1991-2	Olszewski (President) and Hanna Suchocka (PM) government 1 January 1992The Agricultural Property Agency of the State Treasury begin privatising state farms
2 August 1992	Poland's parliament approves constitutional changes to strengthen prime minister and president
1 January 1993	Czechoslovakia divides into the Czech and Slovak Federal Republics
11 February 1993	Poland's parliament opens crucial debate on national budget
5 April 1993	Modified Polish mass privatisation proposals approved in parliament
30 April 1993	Parliament passes privatisation bill
28 May 1993	Prime Minister Hanna Suchocka defeated in no-confidence vote proposed by deputies from the Solidarity's union
27 August 1993	Currency devaluation by an average of eight per cent against a basket of western currencies
19 September 1993	General election
13 October 1993	The two winning parties in the general election-the former communists of the SLD and the former pro-communist Peasants' Party agree to form a coalition government
18 October 1993	Waldemar Pawlak formally appointed Poland's new Prime Minister
25 October 1993	Poland's new coalition agree on Cabinet
5 March 1994	Polish parliament passes budget in tune with IMF guidelines
25 March 1994	President Lech Walesa blocks the appointment of Geneva-based economist Dariusz Rosati, a former communist as finance minister
8 April 1994	Poland applies to join the European Union

16 April 1994	President Walesa threatens to dissolve parliament and call fresh elections as argument over new finance minister continues
25 April 1994	Poland gives Nato its plans for developing military co-operation as part of the Partnership for Peace programme
5 July 1994	Workers at Fiat factory in Poland vote to strike in support of a pay claim
5 July 1994	Walesa threatens to resign if he is forced to accept an easing of the country's anti-abortion laws
15 July 1994	European Investment Bank announces plans to lend Poland $1.2bn for infrastructure projects, primarily highways linking the country with the EU
27 July 1994	European Commission agrees further steps to speed up integration of Central and Eastern Europe
4 October 1994	EU foreign ministers agree a broad strategy for extending bloc into Eastern Europe
1 January 1995	Polish zloty redominated (1000 zloty=1 zloty)
9 January 1995	Ex-president of Poland Lech Walesa says he is going back to his old job in the Gdansk shipyards
15 January 1996	Ex-president of Poland arrives at Gdansk shipyard to take up a new job as union consultant
30 June 1995	New privatisation bill passed shifting authority from privatisation minister to regional officials
7 July 1995	Chancellor Kohl suggests that Poland can join the EU by 2000
17 July 1995	Teams of Polish and foreign fund managers draw lots to decide which will have the first choice among the 413 companies in Poland's $2.6bn mass privatisation
21 July 1995	Polish deputies over-ride presidiential veto on new privatisation legislation
30 July 1995	President Walesa plans court action to stop privatisation bill in parliament because he believes it will obstruct sell-offs and foster political patronage

31 July 1995	President Walesa plans court sends privatisation bill to the Polish constitutional court
17 September 1995	Poland and Lithuania say they still want to join Nato despite the objections from Russia
20 November 1995	Lech Walesa is defeated in elections by former communist Alexander Kwasniewski
25 November 1995	President-election Alexander Kwasniewski resigns from the Social Democrat party he had helped found so that they can treat all Poles in an 'equal way'. It is also confirmed that he did not gain the university degree that he claimed during the campaign
29 November 1995	European Commission says expansion of EU eastwards will be costly but not impossible
20 December 1995	Russia denies allegations made by Lech Walesa that the prime minister Josef Oleksy had contacts with Russian agents
21 December 1995	Polish interior minister, a supporter of Lech Walesa assures the prime minister
24 January 1996	Josef Oleksy (PM) resigns because of investigation into his former links with the KGB
31 January 1996	Wlodzimierz Cimoszewicz nominated as new Polish prime minister
7 February 1996	Poland's new government is sworn in; the privatisation minister, Wieslaw Kaczmarek survives an attempt to oust him by the Polish Peasant party, the junior member of the governing coalition
19 February 1996	Results of Polish referendum on privatisation show that only 29 per cent of the electorate voted, indicating a defeat for the solidarity opposition
4 March 1996	Polish president promises more privatisation despite low turnout in referendum on the issue last month
6 March 1996	EBRD says it faces a crucial test in the next few weeks because it has used up most of the capital it had available to lend
18 March 1996	Western government shareholders in EBRD reported to be ready to double the capital of the bank, but over a 13 year period

	Gdansk shipyards faced with closure
29 March 1996	Polish government proposes sale of majority stake in the Gdansk shipyards
	EU leaders meeting in Turin agree common agenda for enlargement of union to include the countries of Eastern Europe by the end of the century
14 April 1996	EBRD president warns of poor banking system in the region
	Leaders of Poland and Bulgaria agree that eastern expansion of Nato is needed
8 June 1996	Shareholders at the Gdansk shipyard, led by the Polish government, vote to declare it bankrupt
17 June 1996	Report that Brussels sees 2002 as the earliest probable date for accession of former communists countries in Central and Eastern Europe to the European Union
11 July 1996	Poland becomes a member of the OECD
13 August 1996	Poland reports $3.1 bn trade deficit for first six months
1 September 1996	Pope denounces Polish plans to liberalise abortion laws
3 September 1996	Poland refuses US request to sell tanks to Bosnian army
4 September 1996	Polish foreign trade minister sacked
12 September 1996	President Chirac of France tells Poland it should be in the EU by 2000
13 September 1996	EC officials say Poland might be able to join EU by 2002
1 October 1996	Cabinet reshuffle in Poland expected to lead to slow down in privatisation

LIST OF ABBREVIATIONS/ACRONYMS

ADF: Agricultural Development Fund
AMS: Aggregate Measure of Support
APA: Agricultural Property Agency of the State Treasury
APEC: Asian Pacific Economic Cooperation
AR: Autoregressive (exact likelihood method)
ARMA: Association for the Reconstruction and Modernisation of Agriculture
ASAP: Agricultural Sector Adjustment Programme
BLUE: Best Linear Unbiased Estimator
CAP: Common Agricultural Policy
CEE: Central and Eastern Europe
CEECs: Central and Eastern European Countries
CEFTA: Central European Free Trade Area
CES: Constant Elasticity of Substitution
CIS: Commonwealth of Independent States
CMEA: Council for Mutual Economic Assistance (or Comecon)
CSEs: Consumer Subsidy Equivalents
D-W: Durbin-Watson
EBRD: European Bank for Reconstruction and Development
EC: European Community
ECUs: European Currency Unit
EDF: European Development Fund
EFTA: European Free Trade Association
EIB: European Investment Bank
EU: European Union
EUROP: Quality assessment classification system
FAPA: Foundation of Assistance Programmes for Agriculture
FDI: Foreign Direct Investment

FSU:	Former Soviet Union
GDP:	Gross Domestic Product
GLS:	Generalised Least Squares
GNP:	Gross National Product
GUS:	Glowny Urzad Statystyczny (Central Statistical Office)
IGC:	Inter-Governmental Conference
IMF:	International Monetary Fund
IV:	Instrumental Variables
ML:	Maximum Likelihood
MPS:	Material Product System
NAFTA:	North American Free Trade Agreement
NGOs:	Non-Governmental Organisations
NIS:	New Independent States
NMP:	Net Material Product
OECD:	Organisation for Economic Cooperation and Development
OLS:	Ordinary Least Squares
PCR:	Principle Components Regression
PHARE:	Poland and Hungary Assistance for the Reconstruction of the Economy
PSEs:	Producer Subsidy Equivalents
PSL:	The Peoples Peasant Party
RSS:	Ratio of the sum of squared differences
RTD:	Research, Technology and Development
SF:	Stochastic Frontier
SLD:	Left Democratic Alliance
3SLS:	Three-Stage Least Squares
SMAC:	Solow, Minhas, Arrow and Chenery
SMEs:	Small and Medium-sized Enterprises
SNA:	United Nation's System of National Accounts
SOIs:	State-owned Industries
TL:	Transcendental/Translog

UK:	United Kingdom
US:	United States
WTO:	World Trade Organisation

For Mum, Dad and Family.

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Chapter 1
Introduction

1.1 Introduction

The collapse of Communism in the Former Soviet Union and across Central and Eastern Europe (CEE) at the end of the 1980s is one of the most significant events to have occurred during the latter half of the 20th century. A number of factors have been identified as the catalysts for the rejection of socialism as a politically and economically viable doctrine. These include: spiralling economic decline; failing performance in the state-operated industries (SOIs); neglect of consumer-oriented markets; and growing political and social discontent. There had been earlier attempts to introduce limited change. During the 1960s, 1970s and early 1980s, however, these were essentially piecemeal efforts and they failed to resuscitate an ailing, centrally planned administrative system (Merridale and Ward, 1991; Kwiecinski and Quaisser, 1993; and Stuart and Gregory, 1995).

The ideological resurgence of 'market socialism'[1] in the late 1960s resulted in central planners combining both market and plan. Whilst the state owned the means of production, two areas of the economy, namely, the distribution of consumer goods and the allocation of manpower, were largely left to the market mechanism. Wages and salaries paid out in the production process constituted the main means of payment for the consumer goods and services made available in the plan (which in turn provided the main incentive to work). Avoidance of inflation meant equating the cash (notes and coins) injected into the economy with the aggregate supply of consumer goods and services at established prices. The central planners attempted to set the prices of goods and services at the market clearing level, having estimated demand against planned supply of a good or service (a perfectly inelastic supply curve). However, as demand was often incorrectly estimated in the first place and prices were set for long periods of time, market forces were rarely in equilibrium. If demand exceeded supply, queues resulted; when supply exceeded demand, stockpiles occurred. As for manpower allocation, the skilled labour demand curve was perfectly inelastic on the basis that, with existing technology, the number of workers required is given by the planned level of output. Thus, an increase in production targets would necessitate an increase in the demand for labour resources (a shift in the labour demand curve to

[1] Oskar Lange is generally considered as the father of market socialism theory, having developed the model in two large studies in 1936-7 (Lavigne, 1995).

the right). If the total supply of skilled labour was not increased, a rise in the equilibrium wage rate would attract skilled workers from other sectors. However, if the supply curve could be shifted to the right, through party propaganda, new training schemes and a higher wage rate, then a new equilibrium wage level is theoretically achievable. The increased supply is the result of two sources: workers attracted from other sectors and the newly skilled (Jeffries, 1993).

By the mid 1980s, it was becoming extremely apparent that the socialist planners had evaded two important issues: first, the demand for participation and second, the need for private ownership (Blazyca, 1996). In 1987, perestroika[2] ('restructuring') and glasnost[3] ('opening') formed the rudimentary awakenings to the democraticisation of all public life. Radical economic reform[4] in the Soviet Union had began. However, it was not until 1989 that substantial efforts were made simultaneously towards economic transformation in the Soviet Union, Germany and in Poland[5] (Merridale and Ward, 1991; Kwiecinski and Quaisser, 1993; and Stuart and Gregory, 1995).

To date, the 1990s have been an era in which the focus has been largely upon contemporary transition from state socialism to market capitalism; a journey which is viewed as 'uncharted and controversial[6] in both theory and in practice' (Stuart and Gregory, 1995: 73). The need for economic reform is no longer in question, but the pace of economic change has been a

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[2]In essence, perestroika contained a series of decrees which detailed political and economic reforms to the prevailing system. Modifications to the political structure resulted in wider popular participation. Economic reforms were multi-faceted and included a reduction in the capacity of planners and ministerial authority over the control of SOIs and an increase in worker participation in enterprise decision making; expansion in co-operative activities and self employment; private activity and property rights in agriculture; industrial modernisation; the opening of the soviet economy, including encouragement of joint-ventures with Western capital, and price reform (Merridale and Ward, 1991; and Stuart and Gregory, 1995).

[3]This entailed the opening of Soviet society from a cultural standpoint, in terms of the media, literature and the general conduct of daily life (Merridale and Ward, 1991; and Stuart and Gregory, 1995).

[4]Kornai (1995) views economic transition more as a 'revolution' than 'reform'. He contends that whilst reform yields important changes, it retains the fundamentals concerned. Revolution, however, changes radically the fundamentals bringing about a change in the system (Kornai, 1995).

[5]Whilst emergency measures were taken in Poland and the Soviet Union to combat hyperinflation, Soviet economic problems were heightened by substantial increases in the state budget deficit, decline in Gross National Product (GNP) and virtual collapse of the Russian ruble on the foreign exchange. In November 1989, the reunification of Germany began with the disintegration of the Berlin Wall (Stuart and Gregory, 1995).

[6]Theorists on the economic convergence of former socialist countries advocate different economic remedies. For example, the institutional economists (see Casson, 1994; Blazyca, 1996; and Hoen, 1996) and the development economists, who emphasise the need for a mixed market (refer to Cook and Nikson, 1995).

contentious issue since the processes of economic transition began[7] (Lavigne, 1995). There are two basic approaches which have been used. On the one hand, rapid restructuring programmes, also referred to as 'Shock Therapy' and 'Big Bang' (BB) have been adopted in Poland, former Czechoslovakia (until 31 December 1992)[8] and Bulgaria[9] (Sachs, 1992; Balcerowicz, 1993; and Lavigne, 1995). In contrast, other countries have applied a more organic restructuring procedure. 'Gradualism'[10] emphasises institutional and microeconomic development[11]. This has been implemented in countries such as Hungary, Ukraine, Romania and China. Whilst Slovenia uses an erratic combination of both fundamental approaches, Russian transformation has been described as 'shock without the therapy'[12] (Lavigne, 1995: 120). Furthermore, in light of growth rate forecasts (1997),[13] economic recovery appears to have been faster in the countries which

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[7]For further discussion, see for example, 'A New-Institutionalist Story about the Transformation of Former Socialist Economies: A Recounting and an Assessment' (1996) by P. M Lichtenstein, Journal of Economic Issues, Vol XXX, No. 1: 243-265; 'The Economics of Transition' (1995) by M. Lavigne; 'The Evolutionary Transition to Capitalism' (1995), edited by K. Z. Poznanski; 'Economic Transformation in Central Europe' (1993) edited by R. Portes; 'Introduction: Shock Therapy and Its Discontents' (1993) by D. Ost, TELOS, No. 92, Summer; and 'The 'Big Bang' versus 'Slow but Steady': A Comparison of the Hungarian and the Polish Transformations' (1992) by I. Abel and J. P. Bonin, Discussion Paper No. 626, Centre of Economic Policy Research.

[8]The Federal Czech Republic (since 1 January 1993) continued with ultraradical reform, whilst the Federal Slovak Republic (since 1 January 1993) eased their previous policies (Lavigne, 1995).

[9] 'Shock therapy' in concept, but slow in implementation (Lavigne, 1995).

[10]Benefits include lower social costs, such as lower unemployment.

[11]This encompasses extensive development in all constitutional and legislative aspects; development of financial markets and commercial banks; democracy and political pluralism.

[12]Although the various successive programmes announced and partly launched in Russia during 1992-3 were 'shock therapy' in theory, they were never fully implemented because of political conflicts either between the government and parliament or the Central Bank or between the government and regional lobbyists. The end result: prices were never fully freed; credit was never really tightened, nominal wages were allowed to outgrow inflation and currency convertibility was never achieved (Lavigne, 1995).

[13]July 1997 Economic growth forecasts by Organisation of Economic Cooperation and Development (OECD):

	1996 (%)	1997 (forecast)
Bulgaria	-10.9	-6.0
Czech Rep.	4.4	2.6
Hungary	0.8	2.4
Poland	6.0	5.0
Romania	4.1	-1.0
Russia	-6.0	2.0
Slovak. Rep.	6.9	5.0
Slovenia	3.5	3.5

(Source: East European Markets, July 1997: 14/6) adhere to BB rather than those countries which adopt a more 'gradual' plan (social costs aside). Despite there being no single, absolute theory on transition, the disintegration of a moribund central planning framework with the nascence of a market oriented system requires four basic, yet inter-related components: microeconomic concerns (privatisation, markets, price liberalisation and restructuring); macroeconomic issues (stabilisation, macro balance, monetary/fiscal matters); international trade (organisational arrangements and currency changes) and safety net problems (pensions, health care and unemployment insurance) (Healey, 1994; and Stuart and Gregory, 1995; detailed also in 2.4).

Reformation in post-communist Europe is reshaping the global economy, particularly the adjacent markets of post-industrial Western Europe. Successful transformation is cited as being an inherent feature in the evolution of 'Europe', as a global player in the world economy (BBC Productions, 1993). Despite a high degree of heterogeneity[14] in the Central and Eastern European countries (CEECs), the Commonwealth of Independent States (CIS), the New Independent States (NIS), and the Baltic States, all are undergoing large-scale ideological, political, economic, social and technological transition, a process converging towards a market-oriented economy (Healey, 1994). However, the re-integration of the 'Partners in Transition'[15] and other former communist satellites into both the European and the global arena is proving extremely difficult.

This thesis is set amidst the backdrop of political and economic change in CEE. Of these countries, it is Poland which is at the heart of this research programme. Poland's grasp of the BB programme of economic transition has affected the whole economy. Nonetheless, the aim of this thesis is to analyse how one particular sector of the Polish economy, namely agriculture, has responded during the embryonic years of economic transformation. The Polish primary sector is distinctive from the other farming sectors of CEE in that small, privately-owned subsistence farms are the crux of the rural community. As such, the Polish primary sector and more specifically, the economic future of the private family farm, are the foci of this study. Indeed, economic stabilisation and agricultural restructuring will mean larger and fewer private farms, with technological advancement leading to economies of scale and economies of scope. At this point, it is appropriate to identify briefly some of the characteristics of the Polish farming system and to compare it with the primary sector of other CEECs. Since farming forms such an integral part of

[14] In terms of development, size, religious beliefs and ethnic composition.

[15] These include Hungary, Poland, the Federal Czech and Slovak Republics (since 1 January 1993) and Slovenia.

the post-socialist economy[16], agricultural changes in response to post 1989 economic transition will have a profound impact on all aspects of Polish economic and social life (Berend and Ranki, 1974; Dawson, 1982; and Karp and Stefanou, 1992).

Agriculture is important to all CEECs and Poland is no exception. The agricultural contribution in Gross Domestic Product in 1993 was 6.3 per cent in Poland, 6.4 per cent in Hungary, 10.0 per cent in Bulgaria and 20.2 per cent in Romania.[17] Moreover, in 1986 whilst 18.4 per cent of Polish agricultural land was owned by the state and 3.6 per cent operated as co-operatives, an overwhelming 75.9 per cent of agricultural land lay in the hands of family farms, with an average size of 6 hectares.[18] In other (former) soviet satellites, the situation was the reverse. For example, in 1986, 86.5 per cent of farming land lay in either state or cooperative hands in Hungary; the corresponding figures for Bulgaria and Romania were 90.0 and 84.4 per cent (Agra Europe, Special Report No. 56, 1990; and Burrell, Hill and Medland, 1990). Indeed, the spatial distribution of Polish state-managed farms was uneven, clustered in the most productive areas of Western and Northern Poland.[19] In 1993, 25.6 per cent of Poland's workforce was engaged in agriculture and 40 per cent of family farms were run by farmers of retirement age and above[20] (Szemberg, 1992a; and European Commission, 1995). A similar picture emerges in the rural communities of other CEECs. In 1993, 10.1 per cent of the total population was employed in the Hungarian primary sector. In Bulgaria and Romania, agricultural employment represented 21.2 and 35.2 per cent of total employment (European Commission, 1995). Indeed, 23 per cent of Bulgarian farmers in vegetable production were also over 60 years old at the end of 1990 (Agra Europe, Special Report No. 56, 1990).

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[16]This may be attributed partly to policy-induced overexpansion of agriculture in the CEECs, relating to the particular role which farming was made to play under the centrally-planned system to provide abundant supplies to meet local needs (Tangermann, 1994).

[17]These figures contrast with a EU (15) average of 2.5 per cent in GDP. The EC 15 include Austria, Belgium, Denmark, France, Finland, Federal Republic of Germany, Greece, The Republic of Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and The United Kingdom (European Commission, 1995).

[18]Polish agricultural data suggests the average size of private farms has actually increased to 7.5 hectares during 1988-1993 (various GUS publications, 1988-1994).

[19]See also Table VI.1, Appendix VI.

[20]Whilst 40 per cent of farmers are aged between 60-70 years old, 32 per cent are above the age of 70 (Szemberg, 1992a).

1.2 Aims and Objectives

There are two principal aims to this research. The first seeks to analyse the response of Polish farming to the on-going process of economic reform. The second details the role of agriculture in socio-economic development generally, focusing on causal change in Polish arable production. This thesis acknowledges that historical development and changes in rural settlement have shaped the uneven spatial distribution of the state and private elements of the Polish primary sector. However, the research is not simply an appraisal of its retrospective development. In fact it is a production-based, supply-side analysis of the relationship between agricultural output and inputs. Thus, it evaluates econometrically the determinants of agricultural supply. The range of investigation therefore necessitates the consideration of issues surrounding economic transition, its future implications for Polish agricultural production and the role of agriculture in economic development. Whilst the empirical research is based predominantly on the interrogation of published and unpublished official agricultural statistics, it is also augmented with primary source information, gathered from a series of semi-structured face-to-face interviews with 'key actors' [21] in Poland (1993/4) and Brussels (1994) (Appendices I and II).

These aims can be translated into more specific objectives:

(i) to identify the variables which have contributed to arable production growth during the early years of economic transformation;

(ii) to explain the spatial (northwest, northeast, southeast and southwest) and sectoral (state and private[22]) differentiation in sources of arable production growth;

(iii) to determine the stage of agricultural development in Polish farming, and thereby analyse the implications on the rural community of the Polish government reform policies.

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[21] 'Key actors' included a number of private Polish farmers and (former) state farm managers located in the Wagry and Rzgow regions of the Lodz, Skierniewice and Piotrkow voivodships (counties), both Polish government and European Union (EU) officials, local government representatives and Polish academics. Phase I of the interviews was carried out between May-July 1993 in Poland. Phase II took place in March 1994 in Brussels and Phase III completed the exercise in October-December 1994 in Poland.

[22] This study focuses primarily on the two key sectors of Polish agriculture-(former) state and private (defined in section 5.4.1). As only 3.6 per cent of all Polish land belonged to cooperative farming in 1986, this group is omitted from the econometric model (documented in Chapter 6).

1.3 Focus and parameters of the thesis

This study of Polish agriculture requires both national and regional spatial analyses. At the national level, the fundamental concern is the economic performance of Polish farming and its affiliated industries. This necessitates a review of the role of property rights concerning rules of access to land. Private property rights are an intrinsic feature of a market economy as they provide the appropriate incentives within the agricultural sector (Braverman et al., 1993). Evolution in the economic and legal rights to property is integral to development in transitional farming (section 1.4.2.1). This thesis also entails an assessment of the role of government departments and agencies, regional and local authorities, together with an examination of the nature of their intervention in economic transformation. Some changes are already visible, for example, the partial privatisation of large, state-operated farms, agricultural promotion and marketing programmes, and social and agricultural policies for the rural economy. Other important considerations are the role of education, research, technology and development (RTD); rural infrastructure and the environment; private, public and foreign sources of investment; foreign exchange rate policy and increasing trade competitiveness in both domestic and foreign markets (Chapters 2 and 7). At the regional level, subdivision of secondary source statistics into eight distinct regions[23] emphasises the spatial diversification of Polish farming. In addition, micro-level data gathered at the farm level[24] together with primary source information derived from the 'key actor' interviews also help to contextualise the results derived in the regional investigation (Chapters 5, 6 and 7).

The fulcrum of the research is a quantitative study of the economic response of the Polish agrarian sector during early transition. Whilst production theory provides the conjectural underpinnings to this investigation in Chapter 3, Chapter 4 analyses its empirical context, drawing upon earlier work from both Polish and non-Polish studies. The production function is one of the methodological tools available to economists as it identifies the relationship between output and inputs. Specifically, it is the 'Cobb Douglas' production function which has been chosen as the particular estimator for this research, despite being originally used within the secondary sector (see 1.4.2.2). It has been used because of its simplicity and suitability for use with real measures of inputs and in its general application to primary sector data (Florkowski, Hill and Zareba, 1988;

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[23]Detailed in 5.4.1 and 5.4.2.

[24]Refer to section 5.3.

Boyd, 1988, 1991; Yaron, Dinar and Voet, 1992; Ali and Parikh, 1992; Fleisher and Liu, 1992; McGuirk and Mundlak, 1992; Johnson et al., 1994; Battese, Malik and Gill, 1996; Bhattacharjya and Bhattacharjya, 1996; Hatziprokopiou, Karagiannis and Velentzas, 1996; and Sharif and Dar, 1996).

The underlying assumptions and caveats within the production model relevant to the Polish arable sector are considered in Chapter 5. Specifically, the model identifies a number of 'conventional' and 'nonconventional' explanatory variables which affected Polish crop production between 1988-1993. Whilst some variables are routinely included in models of production (such as capital and labour), this particular production function also incorporates farming inputs (such as fertilisers and cultivated land). Primary sector data for each 'wojewodztw' (voivodship)[25] were collected from a variety of sources in Warsaw and Lodz during 1993/4[26] and prepared (modified, where necessary) for regression analysis.[27] Chapter 6 focuses specifically on regression; detailing the exact model specification, two alternative estimation techniques; and the routine diagnostic tests.

The seventh chapter consolidates the two principal objectives of the research (see 1.1). First, the regression parameters (documented in Chapter 6) identify the main sources of growth in Polish arable production, and thereby establish the specific stages of agricultural development within Poland's primary sector. Second, the fundamental contributors to Polish crop production are evaluated within the context of present Polish government policy objectives (outlined in Chapter 2). The results derived in this empirical analysis are contextualised within the theoretical framework of agricultural development and economic transition. Therefore, this empirical investigation enlarges upon previous research in this field by synthesising various aspects of agricultural development theory within the present climate of Central and Eastern European economic change.

Whilst much work has been undertaken linking the general contribution of agriculture to

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[25] The 'voivodship' which is equivalent to the English county relates to the political boundaries set out by central administration. There are regional authorities in each voivodship which carry out central government policy. There are numerous departments, covering such aspects as public utilities, taxes and the environment. There are currently 49 (see sections 4.2.1 and 5.3).

[26] Both quantitative and qualitative data collection was facilitated by the awards of a fellowship from the Polish government in 1993 and 1994.

[27] The study utilised the econometric package 'Shazam'.

economic development (Lewis, 1954; Fei and Ranis, 1964; Jorgenson, 1966; Lipton, 1984; and Rayner and Ingersent, 1991), the role of agriculture in the transformation of a centrally planned economy has been largely neglected (Balcerowicz, 1993). At the micro level, the fundamental issue is the need to increase agricultural production, whilst being constrained by an inelastic supply of natural resources. In the longer term, technological advancement can counteract these constraints on production, shifting the sector from being a 'resource-based sector to a science-based industry' (Ruttan, 1982: 3). Institutional innovation can be as endogenous to agriculture as technological progress since it facilitates the development and adoption of appropriate technology. Such an example of institutional change may include the establishment of a publicly financed agricultural research system directed towards biological research (Rayner and Ingersent, 1991; and Goldsmith, 1995; detailed in 5.6.1 and 7.2.3).

However, successful transition, from central planning to a market-oriented system, requires more than just technological or institutional innovation. It is the ideological transition which is cited as being one of the chief problems hampering the economic development of 'post-socialist' Europe. There is a greater need for 'behavioural' reform at the micro level in all sectors of society so as to ensure sustained economic growth (Duczkowska and Duczkowska-Piasecka, 1988; van Zon, 1992; and Pugh, 1993). Indeed, three types of private farmers, operating simultaneously within the Polish rural community have already been identified in the literature; those who have successively adjusted to the 'market' mentality (10 per cent); those who are presently adapting, but are cited as having no 'real economic future' (20 per cent); and finally those who are 'relatively poor with virtually no prospects for improvement' (70 per cent) (Kwiecinski interview, 1994). Hence, whilst there may be improvement for 20 per cent of private farmers at most, it is inevitable that the remaining 80 per cent will be forced out of the agricultural sector (Szemberg and Kwiecinski interviews, 1994).

It is also important to recognise the key issues of current debate within agricultural economics literature as they will influence the Polish primary sector. Crucial issues for developing economies include the identification of the sources of agricultural growth; technical inefficiency of production; input misallocation; technical innovation and output loss (Battese, Malik and Gill, 1996; Bhattacharvya and Bhattacharvya, 1996; and Sharif and Dar, 1996). Additional factors involve prospects for trade (Griliches, 1992; Ball, 1992; and Liu, Yao and Greener, 1996); and welfare (Islam and Taslim, 1996). Nevertheless, it is agriculture's interface with the environment;

population growth; and sustainable agriculture and development which are increasingly dominating the agricultural economics literature (Houck, 1992; Smith, 1992; Lutz, 1992; Whitby and Adger, 1996; and Potter and Lobley, 1996).

Chapter 8 is the conclusion. It reflects on the future potential of Polish agriculture and identifies the most important issues which will aid the development of Polish farming and re-define its long-run agricultural production function.

1.4 Context and scope of the study

1.4.1 Empirical Context (Chapters 5, 6 and 7)

The research combines quantitative and qualitative methodologies. Phases I and III (May-July 1993 and October-December 1994) were associated with the collection of published and unpublished polish agricultural and meterological data (listed in Appendix I). The main sources of reference were the 'Glowny Urzad Statystyczny' (GUS)[28] in Warsaw and Lodz, Poland. Phase I also consisted of a series of semi-structured face-to-face interviews carried out with civil servants from local and central government; family farmers and leading academics. In Phase II (March 1994) issues raised in Phase I were explored in greater detail during a trip to Brussels where the second series of discussions took place with delegates from 'Poland and Hungary Assistance for the Reconstruction of the Economy' (PHARE)[29], agricultural and trade departments at the EU and the Polish Mission. Phase III (October-December 1994) consisted of a succession of follow-up interviews with the key actors, identified earlier in Phase I together with representatives from The World Bank, the British Know-How Fund, PHARE, the European Development Fund and the British Embassy (listed in Appendix II). Second phase interviews with local farmers and visits to Regional Agricultural Extension Service Centres completed the empirical fieldwork (section 5.3).

Phases I and III were spent at the Department of Environmental Economy and Spatial Policy, University of Lodz, Poland. During my first visit, preliminary contact was made with leading ministerial officials and academics as well as local farmers in two study areas: Rzgow and Wagry (bordering the Lodz/Skierniewice/Piotrkow voivodships (counties) see Map III.1, Appendix III). Rzgow and Wagry share some similar characteristics. For example, small, self-sufficient, family farms dominate the agricultural landscape. However, Wagry has an additional feature of a (former) state-owned farm; it is also close to Koluscie, a major town; and it has transportation links to other cities. Both farming regions were chosen as suitable locations for conducting primary research, after consultation with colleagues at the University of Lodz. Pilot interviews were held with agricultural advisors and representatives, together with a number of farmers yielding detailed primary data and ad hoc localised information relating to economic transition (section 5.3).

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[28]Central Statistical libraries.

[29]Defined in section 2.5.4.

1.4.2 Theoretical context

1.4.2.1 Theory of Property Rights

The successful privatisation of state-owned assets across post communist Europe has necessitated a change in both legal and economic contractual arrangements. Although legal rights[30] as a rule enhance economic rights, they are neither necessary nor sufficient for the existence of the latter. The rights which specify the ways in which an asset (or a person) may be used in a specific way or for particular periods of time are known as property rights. Property rights comprise of the powers to consume, alienate or derive income from an asset. The rights human beings have over assets are never fixed; they are a function of their own efforts at protection, of other people's capture attempts, and of government intervention (Becker, 1977; and Barzel, 1989).

Fundamental to the theory of property rights is the existence of a competitive market system where mutual exchange of assets and their property rights occurs. In order to generate income from, or exclude others from these assets, the theory of exchange predicts that the forces of demand and supply will allocate resources until pareto optimal conditions hold.[31] Goods are rationed to their highest valued use by this process because free exchange of private property excludes individuals on the basis of willingness to pay. In doing so, individuals internalise (take into account in their decisions) the costs (benefits) their actions impose on others. A pareto optimal outcome will be produced by market forces if private property rights are well defined, there are no public goods, transaction costs[32] are zero, and no individuals possess monopoly power. The theory thus implies pareto optimality will be accomplished from restructuring centrally-operated farms into privately-owned producing units (Gifford and Santoni, 1979; and Gravelle and Rees, 1984).

The concept of property rights is closely related to that of transaction costs. The Coase Theorem[33] is relevant in situations for which transaction costs (costs of reaching agreement)

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[30] Implemented through bankruptcy law (defining the limits of liability), contract law and competition law.

[31] That is goods are rationed to their highest valued use, maximising the net social dividend.

[32] Defined as the costs associated with the transfer, capture, and protection of rights (Barzel, 1989).

[33] See R. H. Coase, 'The Problem of Social Cost', Journal of Law and Economics, Vol 3 (1960), pp. 1-44.

between parties are low[34] and when income effects are absent.[35] When these conditions hold, the theorem implies that resource allocation will be efficient and will not be affected by the initial assignment of property rights. Furthermore, resources will be used where they are most valued, regardless of which of the transactors assume liability for his or her effects on the other (Gifford and Santoni, 1979).

Land or property under government control is defined as 'common' or as being in the public domain. However, the distinction between the private and public sector is not simply a distinction between the presence or absence of private property rights as such rights are necessarily present in both systems. The difference lies instead in organisation and the rewards under which producers tend to operate. Private producers are more readily given the opportunity to assume the entire direct effects of their actions. In the government sector, people assume a smaller portion of the direct effect of their actions. Constraint on exercise of property rights as well as the economic environment in which farmers operate (including the taxes they have to pay and competition among food processors and distributors for the goods that they produce) affect returns to agricultural resources, and thus the value of the agricultural assets themselves (Barzel, 1989; Braverman et al., 1993).

Central to the study of property rights is the study of contracts. Contracts, whether formal or informal, reallocate rights among contracting parties. Since 1990, assets once owned by the Polish socialised agricultural sector have been either rented or sold to private farmers,[36] altering property rights to agricultural factors of production, such as land and labour. Whereas large-scale state managed farms typically employed a considerable number of workers on fixed-wage contracts, the reorganisation of collective production has resulted in the substitution of fixed-wage contracts with fixed-rent contracts and sole ownership. The impact that these alternative arrangements have on incentive, factor use and productivity are reviewed hereafter.

Under the wage contract, (former) state sector employees gained by shirking, exerting

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[34]Transactions costs are low when the parties involved are few in number (Gifford and Santoni, 1979).

[35]Income effects are absent when the parties involved are profit maximising firms. If on the other hand, one or more of the participants are consumers, the wealth positions of the individuals involved effect the initial assignment of property rights, arbitrage and the final allocation of resources. According to Coase's theorem, however, the final outcome will still be efficient despite different assignments of property rights and the final resource allocation (Gifford and Santoni, 1979).

[36]Detailed also in 2.5.3, 5.4.1 and 7.2.3.

themselves less than they would were they self-employed. With imperfect[37] and costly supervision and limited punishments for shirking, workers were not fully penalised for a reduction in effort. However, shirking was not the only problem for socialised farming. Centrally planned agricultural production effected efficiency as it provided no incentive for individual initiative in response to weather or changing technology. These problems went alongside other well-known organisational deficiencies such as soft budget constraints and civil service restrictions ensuring job security. However, a reduction in much of the risk faced by the typical farmer, specialisation in production and economies of scale are cited as being successful aspects of state-managed agriculture.[38]

An alternative collaboration between owners of land and labour is the fixed-rent contract. By the end of 1993, 27 per cent of former state owned land in Poland had been rented to private farmers.[39] Tenants who cooperate with landowners by renting their land pay a fixed amount for its use. Output will differ from that expected because of random fluctuations and the extent to which tenants alter their own effort. Under rental contracts, the incentive for tenants to shirk is not as strong as it is with those who work under the fixed-wage contract as they retain a portion, but not all, of their marginal product. Losses arising from the tenancy contract, however, are due to high transaction costs, caused by informational problems. For example, a landlord is more likely to rent parcels of land that are less easy to exploit to new tenants given imperfect knowledge regarding their performance (Barzel, 1989).

Private farmers are the main agricultural producers in Poland. Between 1990-3, a further 2 per cent of former state-owned land was transferred to the private sector. Sole ownership is devoid of incentive problems typically found when the property rights of land and labour do not belong to the same individual. However, there are two groups of transactions costs generated from this type of contractual arrangement. First, it is extremely unlikely that capital and human investment follow the same pattern of land ownership. In other words, a farmer may possess the property rights of a plot of land and employ a given number of farm workers to farm that land, but it is improbable that he will also be able to provide the correct assortment of tools to produce maximum output. A mutual exchange of factors to correct resource misallocation would reap a

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[37]As output is subject to variability in random factors (such as weather and pests), changing technology as well as worker's contributions, it is difficult to isolate the effect of a change in effort from a change in other factors.

[38]Barzel, 1989; and Braverman, 1993; refer also to 2.4, 2.5.3, 5.5.1.1 and 7.2.3.

[39]See also 2.5.3 and 7.2.3.

greater harvest yield.

The second set of transaction costs is due to losses in specialisation when one individual owns and uses all factors of production. Both landowners and farm labourers engage in activities to maximise their returns.[40] A person who owns both assets cannot profitably specialise as much as the two individual owners of the assets can. The gains from sole ownership therefore must be balanced against falling output caused by loss of specialising (Barzel, 1989).

1.4.2.2 Theory of Agricultural Production (Chapters 3, 4 and 7)

Production economics is a fundamental component of economic theory. It is used extensively within the context of both micro and macroeconomics and is central to international trade theory and concepts relating to economic growth[41] (Beattie and Taylor, 1985; Heathfield and Wibe, 1987; and Kasliwal, 1995). The economics of production is largely concerned with choice among alternative production processes, enterprise selection and resource allocation. The 'Neoclassical' production function is the most widely used production function by economists. It is a mathematical relationship that exists between the output of a firm, sector or economy and its inputs. The amount of inputs required to produce a given output depends on technology, the factor which will determine whether the function is linear or non-linear. The Cobb Douglas Function is the most well known example of a non-linear relationship and it is this specific function which forms the theoretical underpinning to this empirical investigation. However, the model of arable production is developed exclusively within the agricultural context. Therefore, it includes those factors of production which are typically associated with farming (such as land, operative capital, fertiliser and labour). It evaluates the causal change in Polish harvest yields and derives the output elasticities (change in output levels with respect to changes in inputs) during the early years of economic reform.

The Cobb Douglas production function has been applied to farming across varying degrees of spatial analysis in order to identify sources of economic growth, factor substitution and output elasticities (Chapters 3, 4 and 7). It remains one of the most popular tools for development

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[40] For example, landowners provide maintenance work and prevention of erosion to retain the quality of their land. The owners of labour will invest in such activities as maintaining and improving their cultivation skills (Barzel, 1989).

[41] In short, there are three broad sources of growth that can be distinguished using the production-function framework: first, increases in factor supplies, second, increasing returns; and third, technical progress interpreted in the wide sense of anything that increases the productivity of factors other than increasing returns (Thirwall, 1994).

economists as it provides a succinct statistical description of the relationship between technical progress, inputs and output. Accurate interpretation of the empirical output elasticities inform development economists of the structure and organisation of the primary sector. Indeed, the magnitude of the partial elasticity coefficients reflect the relative contribution of each input to economic growth. For example, if the empirically-derived land and labour elasticity estimates are large, it is likely that farming is both land and labour-intensive. On the other hand, if the operative capital or fertiliser elasticity estimates are large, then the processes of agricultural production tend to be more capital-intensive. Elaborating on this theme, Cornia (1985) suggested agriculture to be generally more land and less capital and labour-intensive when it is at an earlier stage of development.[42] This is because farming systems in LDCs rely more heavily upon the relatively inexpensive factor resources (such as land and labour) than the relatively more expensive factors (such as capital or fertiliser) in the production process. As agriculture develops, tools and operative capital inventories become more accessible to farmers. Thus, whilst the magnitude of the capital elasticity estimate increases, the land and labour parameters decline (Cornia, 1985).

Earlier agricultural production studies provide the empirical context for some comparative analysis. In short, the scope of past investigations can be subdivided into five distinct categories. First, cross-country farming studies; second, surveys of agriculture in (former) socialist economies; third, reviews of the primary sector in less developing countries (LDCs); fourth, farming in transitional economies; and fifth, Polish-based agricultural research.[43] However, even the production elasticity coefficients, generated by those studies which focus on the same type of country, are still relatively diverse in magnitude. This is due principally to the haphazard way in which empirical work is performed. The time periods taken, the data used, and the methodology employed, all vary within and between countries. All the same, an overview of the major findings is still very useful. Table 1.1 (below) summarises the range in magnitude of the partial elasticity estimates as derived by each group of countries.

[42] Refer also to 2.2.

[43] Further documentation in Chapters 3, 4 and 7.

Table 1.1: Summary of results of agricultural production studies, by group

Spatial Range	Land	Operative Capital	Fertiliser Usage	Labour
Cross-country studies	-0.03-0.36	0.03-0.31	0.02-0.27	0.30-0.71
(Former) Socialist	0.13-0.34	-0.04-0.14	0.21-0.30	0.12-0.37
LDCs[44]	-0.07-0.86	0.06-0.14	0.02-0.14	0.19-0.56
Transitional Economies	0.47-0.71	0.06	0.06-0.09	0.06-0.41
Polish	0.44^p 0.10^s 1.81^p 0.003^s	0.02^c 0.09^p 0.23^s	0.20^c 0.28^p 0.40^s	0.16^p 0.82^s -0.06^p 0.25^s

Key: p denotes private ownership; s represents state; and c indicates combined data
[Source: Clayton (1980); Wong (1986); Trueblood (1989); Florkowski, Hill and Zareba (1988); Fleisher and Liu (1992); Boyd (1988, 1991); and Johnson et al. (1994)].

The results illustrated in Table 1.1 complement Cornia's (1985) general conclusions. Indeed, the land elasticity estimates generated in farming studies of LDCs and transitional economies usually exceed those found in cross-country, socialist and Polish state sector investigations. The land elasticity parameters of Poland's private sector (Boyd, 1988, 1991; and Florkowski, Hill and Zareba, 1988) are also akin to those produced by countries specified as LDCs or in transition (Lin, 1989; Fleisher and Liu, 1992; and Johnson et al., 1994). A contrasting situation occurs for variables measuring operative capital and fertilisers. Research on farming in the industrialised and socialist countries have generated capital elasticities that are significantly higher in magnitude (Clayton, 1980; Wong, 1986; and Trueblood, 1989). However, estimates of labour's contribution to agricultural production are controversial as there are high labour elasticities in the industrialised as well as the LDCs group. Perhaps a large labour elasticity in the industrialised countries may be explained by labour-intensive production lines, typical of commercial farming. However, the labour parameter produced in analyses by LDCs could just as easily suggest surplus rural population.

Different types of agricultural organisation play a central role in determining the rate of growth and technological advancement in agriculture. The relationship between such factors as farm size distribution as well as tenure rights (see 1.4.2.1) affect performance. Earlier research of land and labour productivities have proved that farm size is inversely related to efficiency

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[44]Pooled data on the LDCs were represented by a dummy variable.

(Cornia, 1985; and Boyd, 1988, 1991). This is owing to the contrasting factor endowments of the large and small scale farms. Although both types (sizes) of farms are technically and economically efficient in their choice of input combinations, the fundamental difference lies with the varying ratios of land and labour. The small farms are those where land is scarce relative to labour and the large farms are where the opposite occurs; labour is scarce relative to land. Small farms are characterised by a more intensive use of land and resource inputs per hectare than large estates. As a result, land yields are significantly higher in small farms (Cornia, 1985). This complements the situation in Poland where the private sector, dominated by small farms, has had consistently higher land and labour productivities than the large farms in the socialised sector.[45 and 46] This implies that small farms can be as least as efficient as the large farms, in developing countries, where the traditional methods of farming prevail (Yotopoulos and Nugent, 1976; and Berry and Cline, 1979). According to Cornia, the yield-gap tends to level off between large and small farms when sufficient job opportunities in the non-agricultural sector become available (Cornia, 1985).

Bachman and Christensen (1967) also identified a specific link between farm size and growth due to technological advancement. The existence of large scale farms in both developed and developing countries, where land is abundant and labour is scarce, has necessitated the application and advancement of technology and mechanisation, which have, in turn precipitated increasing returns to scale. The adoption of newer techniques by the large and medium size farms towards increasing agricultural productivity, usually results in the eventual adoption of the technological methods by the smaller farms. Therefore, in terms of dynamic efficiency[47], the theory suggests a unimodal[48] size distribution will, in general, produce a more efficient allocation of resources, since it utilises more labour without hampering the level of output and without the loss of economies of scale.[49]

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[45]Manteuffel, 1982; Simatupang, 1983; Florkowski, Hill and Zareba, 1988; and GUS, various issues; documented in section 2.4; see also Table V.1, Appendix V).

[46]Institutional rigidities as well as farm size were important factors affecting efficiency in socialised farming (see 1.4.2.1).

[47]Dynamic efficiency is increasing the maximum output available from a given resource base, through technological change.

[48]The 'unimodal' size distribution of farms is one in which the bulk of farms are of intermediate size and a relatively small number are at both the small and large extremes.

[49]Further analysis is carried out in 5.6.1.

1.5 Hypotheses

The combination of the theoretical aspects relating to property rights, agricultural development, economic production and economic transition as well as two sources of empirical data has generated a set of seven hypotheses.

The divestitude of (former) publically-managed Polish farms into private ownership has led to a reorganisation in property rights of the factors of agricultural production. The restructuring of socialised farming has changed contractual obligations in so far as fixed-wage contracts are being substituted with fixed-rent and sole ownership (section 1.4.2.1). This contractual change provides the context for the first hypothesis.

Hypothesis One:	The establishment of private property rights will lead to substantial shedding of the (former) socialised agricultural workforce

The six subsequent hypotheses are derived within the framework of agricultural production and development theory (section 1.4.2.2). Polish farming segregates into private and (former) state ownership and each sector is distinct in organisation, structure and development (sections 2.2-2.3). Private agriculture in Poland is peculiar in that it faces some problems typical of developed market economies, such as food surplus, yet it has to deal with a lack of capital and a poor infrastructure, both more common to developing economies (Braverman et al., 1993).[50] It is therefore hypothesised that private farming in Poland is comparable with small scale, subsistence agriculture in LDCs. Each empirically-derived production elasticity coefficient will fall within the range specified as developing agriculture (depicted in Table 1.1). Therefore, the following four hypotheses describe the magnitude of the national aggregate land, operative capital, fertiliser and labour elasticity coefficients generated by the private sector of Polish farming during 1989-1993.

The range in magnitude of land elasticity parameters derived in agricultural research on LDCs is -0.07 (Kawagoe, Hayami and Ruttan, 1985) and 0.86 (Lau and Yotopoulos, 1968).

[50] A substantial body of research also supports this view. For example, see Dawson, 1981; Manteuffel, 1982; Simatupang, 1983; Pacione, 1986; Duczkowska-Malysz and Duczkowska-Piasecka, 1988; Florkowski, Hill and Zareba, 1988; Boyd, 1988, 1991; Szemberg, 1992abcd; Kisiel and Szemberg interviews, 1994.

Hypothesis Two:	The magnitude of the private national aggregate land elasticity parameter lies between -0.07-0.86.

The LDCs subset in Kawagoe, Hayami and Ruttan's (1985) study of 43 countries generated the lowest operative capital elasticity (0.06). Similarly, analysis carried out by Lau and Yotopoulos (1968) derived the highest operative capital parameter, a value of 0.14.

Hypothesis Three:	The magnitude of the private national aggregate operative capital elasticity coefficient deviates from 0.06-0.14.

A study by Lau and Yotopoulos (1968) produced the lowest fertiliser elasticity parameter, 0.02 and Antle's farming study (1983) generated the highest elasticity for fertiliser consumption (0.14).

Hypothesis Four:	The magnitude of the private national aggregate fertiliser elasticity estimate lies within the range 0.02-0.14.

The range in magnitude of labour's contribution to the process of agricultural production in LDCs is 0.19 (Antle, 1983) and 0.56 (Kawagoe, Hayami and Ruttan, 1985).

Hypothesis Five:	The magnitude of the private national aggregate labour elasticity value ranges between 0.19-0.56.

The sixth and seventh hypotheses relate to the spatial diversification of Polish farming production. The regional land structure and the farm size distribution of present-day Poland is a legacy from Poland's past. A lower level of industrialisation in the Austro-Hungarian Empire meant the south eastern area of Poland suffered from intense population pressure. Small, fragmented holdings, older agricultural inhabitants, many landless labourers and severe rural poverty are now features of this area. Whilst former Russian territory in the central and eastern areas of Poland, displayed similar characteristics, large scale, commercial farms developed in the northern and western areas which belonged to Prussia. After World War II, many of the former estates became state farms and post-war settlers in these areas were much younger than their Central and Eastern counterparts (sections 2.4 and 5.4.2).

Today, private farms in the western and northern areas are generally more capital-oriented than farms in the southern or eastern parts of Poland, where agriculture is perceived to be more land and labour-intensive. Larger private farm units in the north west are more likely to have higher land, labour and capital productivities, leading to economies of scope and scale (5.4.2). A high concentration of large-scale, (former) socialised farms in the area is also likely to have aided the diffusion of newer techniques to increase agricultural productivity and eventual adoption of the technological methods by smaller farms. Using area-specific production functions, the magnitudes of the empirically-derived regional aggregate production elasticity coefficients will reflect spatial variation in Polish arable output. Moreover, these results will illustrate the effects that historical change has had on both the input-output associations of harvest production and socio-economic development in the Polish farming communities (Chapters 6 and 7). The final two hypotheses focus specifically on the private north western sector of Polish farming as it is hypothesised that a more advanced system of agriculture is practiced here.

Hypothesis Six:	The magnitude of the private northwest aggregate land elasticity estimate will be lower than its southern and eastern counterparts.

Hypothesis Seven:	The magnitude of the private northwest aggregate operative capital and fertiliser elasticity estimates will have a greater magnitude than those generated in the southern and eastern areas.

1.6 Structure of the thesis

After this introduction, the thesis divides into 7 further chapters. Chapter 2 focuses on the role of agriculture in socio-economic development; the structure and organisation of Polish farming, as it exists today; and its preliminary reaction to market transition. In preparation for the core of the thesis, Chapter 3 documents the theory of economic production in general. Its focus is on the Cobb Douglas neo-classical production function which is central to the agricultural production literature. The theoretical and empirical limitations of using the Cobb Douglas production function within the primary sector of the economy are emphasised. Chapter 4 analyses the methodological aspects of modelling agricultural output at the global, national and farm level using empirical research from Polish and non-Polish studies. The fifth chapter is devoted primarily to the specification of the explanatory variables used in this model of arable Polish production (1989-1993). It also documents recent trends in Polish harvest yields and the changes in input inventories. Chapter 6 specifies the exact model used and reports on both stages of regression while Chapter 7 contextualises the results derived in Chapter 6 within earlier global, regional and Polish agrarian production studies. It also synthesises these results with an evaluation of the Polish government's social and economic policy objectives until the year 2000. Chapter 8 is the conclusion.

Chapter 2

Agricultural Development and Polish Economic Transition

2.1 Introduction

Chapter Two examines Polish agriculture from three distinct viewpoints: its past, its present and its impact on future economic and social development. The first part (sections 2.2 and 2.3) details the role of farming in the development path and documents the specific stages of agricultural development identified in the literature. Whilst part II (section 2.4) describes the historical setting to Polish farming, as it exists today, the third part (section 2.5) documents the repercussions of economic reforms on levels of food production and consumption since 1989. This part also analyses trading links with Western European markets and Poland's prospective full membership of the European Union (EU), combined with privatisation of the former socialised farming sector and government fiscal policy.

2.2 Agriculture in Development

> "..Agriculture, in its broadest sense, is the supplier of raw materials regardless of the rural system which prevails. It is a partnership between Man and Nature; the former may propose, the latter disposes.." (Venn, 1933: 6).

There are numerous farming systems in operation all over the world. As a result, there are huge disparities between countries with respect to land ownership, farm structures, and agricultural performance. There are a number of stages in agricultural development which have been identified in the literature (Pacione, 1986; and Ilbery, 1989). Whilst there is comprehensive support for both a 'First and a Second Agricultural Revolution'[51], the 'Third Revolution' is termed 'Agricultural Industrialisation'.

In brief, the 'First Agricultural Revolution' dates back to the beginnings of Agriculture (approximately 10 000 B.C), when agricultural activity replaced hunting and gathering in most parts of the world. This shift has been causally related to the growth of population in relation to the increased carrying capacity of agricultural production which led to widespread rural settlement and a dominantly agricultural way of life, albeit providing the base for a small non farming urban population. Subsistence agriculture prevailed, and was (is) characterised by the direct application of human labour, a low level of technology and an emphasis on communal tenure (Grigg, 1974;

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[51]The use of this term itself, is justified by evidence of radical changes affecting substantial portions of mankind, based on successive adoption of new forms of agricultural activity (Pacione, 1986).

and Harlan, 1975).

The 'Second Agricultural Revolution', beginning in the seventeenth century became intimately and rapidly associated with the Industrial Revolution. The shift from subsistence farming to market production was simultaneous with the increase in demand for labour and the provision of an adequate food supply for a rapidly growing industrial labour force. The principal features, which assisted with this transition, lie with independent innovations within farming and encouraged the shift from communal peasant to individual commercial farm operations. Other features included the introduction of new crops, irrigation and land reform (Lewis, 1954; Fussell, 1965; and Jones, 1967).

'Agricultural Industrialisation', the 'Third Revolution', has been occurring since the 1920s, and is characterised by a fundamental shift towards commercial farming. A number of factors are of critical importance, including technology[52], its applications and changing economic parameters, but above all the substitution of an industrial for an agrarian model of organisation for farming and its integration into a total agro-food system. Admittedly, the political ideologies have differed from country to country, yet the economic features ultimately remain the same and hence a common convergence towards agricultural industrialisation has evolved. Modern agriculture[53], therefore, has four common processes.

(i) **Increases in size of the production unit**; a reduction in the number of farms with a simultaneous increase in the size of the farms to achieve economies of scale (see Appendix IV).

(ii) **Specialisation in production**; a shift away from mixed farming towards larger, uniform cropping regimes, with specific emphasis on large-scale, single-type livestock operations.

(iii) **Intensification of capital inputs**; greatly increased investment per farm and farm worker, both in land and buildings (i.e scale), livestock (specialisation), and secondary inputs through the application of mechanical and chemical energy, to facilitate increased output and substitution of human labour.

(iv) **Integration** of farm production with other parts of the total agriculture and food system. Essentially, integration strengthens the linkages between existing input supply and the processing and distribution sectors of agribusiness and farm level production.

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[52]Technological advancement and institutional innovation are paramount to successive development of agriculture (Ruttan, 1982).

[53]Countries which have reached this stage of agricultural development, in varying degrees, include the US, Canada, Western Europe, the CAIRNS group and state farming in former Communist countries.

The combination of these four processes results in overall positive results; output achieved at lower unit cost of production and maintenance of an adequate and 'cheap food' supply to the consumer. However, the full impacts of agricultural industrialisation are not always evident and are commonly viewed as externalities to agricultural productivity. In short, these are grouped as 'environmental impacts'[54] and 'socio-economic impacts'[55] (Vogeler, 1981; and Lonsdale and Endedi, 1984).

2.3 The Polish Context

It seems that Polish agriculture is presently co-existing at two different stages of agricultural development. The (former) socialised farming sector possesses the characteristics familiar to agricultural industrialisation (the Third Revolution), where all four processes, as outlined above, were fulfilled. This sector, however, was never enlarged to the desired level, due to political resilience (see section 2.4).

> (The) "..sectors are not only of unequal degree of economic development, productivity of labour and techniques of production but also different processes of decision making and levels of acceptance of economic choice making by the State which is a consequence of ownership.." (Duczkowska-Malysz and Duczkowska-Piasecka, 1988: 233).

On the fulfilment of these criteria (1-4), economic theory suggests the farms achieve technical and allocative efficiency (refer to 5.6.1). However, other empirical research on private farming suggests the contrary: the Polish peasant farmers have consistently produced a higher level of output than the socialised sector (Manteuffel, 1982; Simatupang, 1983; contrast Tables V.1 and V.2, Appendix V). In support of this view, research undertaken on agricultural systems within Less Developing Countries (LDCs), reinforce this line of argument (Barchfield, 1979; and Cornia, 1985). Subsistence farming, therefore, has been functioning alongside state farms producing the same produce simultaneously, unlike other post communist countries (detailed in section 5.6.1). On this basis, a uniform national agricultural policy is somewhat futile; it is imperative that these sectoral distortions are eliminated. On the one hand, the (former) socialised agricultural sector needs structural reform to improve economic efficiency (the current

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[54]These include soil erosion, pollution and damage to ecosystems, due to the intensification of farm production.

[55]These are primarily caused by the loss of workers due to the reduction in production units and farming populations. The knock on social effects, for example, include the loss of communities and culture.

privatisation programme), and on the other, private agriculture requires full implementation of property rights and the establishment of larger and fewer farms via plot consolidation. In turn, these will lead to economies of scale and scope and improved domestic competitiveness (see Appendix IV).

2.4 Historical Background

The current structure and organisation of Polish agriculture is a direct result of its turbulent past (Davies, 1981; and Topolski, 1986). The very fact that Poland exists at all has surprised both historians and economists alike, in view of its political history (Davies, 1981; Scypiorski, 1982; and Topolski, 1986). Since 1795, countless wars and invasions from its neighbouring empires[56]; successive governments and dismemberment have punctuated its history. However, its' peoples obstinate search for identity, sovereignty and independence has ensured the survival of the Polish race, culture and heritage (Davies, 1981; and Scypiorski, 1982).

The regional land structure and the farm size distribution of present-day Poland is a legacy from Poland's past. The southeast, which belonged to the Austro-Hungary Empire until 1918, suffered from intense population pressure and is still characterised with small, fragmented holdings, many landless labourers and great rural poverty. Few large estates existed and consequently the land reforms after both World Wars had only a marginal effect upon farm structure. With little incentive for young people to remain in farming, an older agricultural population was and, still is characteristic of the southeast. Whilst former Russian territory in the

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[56]Between 1795 and 1918, Polish territory fell under siege from Russia, Prussia and Austro-Hungary (refer to Maps III.2-III.4, Appendix III). The Russian partitions in 1773, 1793 and 1795 embraced mainly the Eastern lands, but extended to include the Congress Kingdom of Poland after 1864. However, political integration did not lead to social assimilation, but to increasing social polarisation as Poles and Russians were forced to live separate lives.

The Prussian partition was generally confined to one area, the Grand Duchy of Posen (present-day Poznan). In contrast with the Tsarist government in the Russian Empire, Prussia enjoyed a certain degree of autonomy. The political community operated within a legal framework and, whilst religious toleration was generally observed, improving social conditions for the less fortunate was seen as a Prussian ethic. The Industrial Revolution came to Prussia earlier than to Russia; urbanisation, private enterprise and modernisation came with Germanisation. Problems did not surface until 1871, when the Prussian Government was overlaid by the confederative machinery of the German Empire. It was not until 1945, when 'Poland' regained the Northern and Western territories that the Prussian Partition breathed its final breath of existence, accompanied with a huge expulsion of Germans.

The Austro-Hungary Empire, created in 1773 and enlarged in 1795 with the addition of 'New Galicia' had a relatively short and politically unstable history. The state intervened in every aspect of social and political life, and Galicia soon became the economically backward area of the Empire, as fewer resources could satisfy the needs of an increasing population. However, poverty, national and political ills failed to stimulate reform, and Galicia's fate was left to both Russia and Germany. Its destruction became inevitable when the Russian army from the east met the German army from the west in Krakow in 1914-5. Finally in 1917-8, stranded by the collapse of the Austro-Hungarian authorities and plagued with starving refugees, Galicia fell to Russification or Germanisation (Davies, 1981; and Topolski, 1986).

central and eastern areas of Poland, displayed similar features, those areas which belonged to Prussia were very different. Farming there was generally on a commercial scale and many large estates existed. After World War II when most of the German population had fled, some of these lands were parcelled[57] and distributed to Poles who had been displaced from eastern territory by the Soviet Union, but many of the former estates became state farms. Post-war settlers in these areas were much younger than their Central and Eastern counterparts (Dawson, 1982; refer to section 5.4.2 and Chapters 6 and 7).

As an independent state, Poland had survived less than two decades, (1919-1939), when its resources were subjected to the mass destruction and exploitation of the Second World War (Berend and Ranki, 1974; and Turnock, 1978). With the defeat of Germany, Poland became a Soviet satellite with a subservient government, sponsored by the Russians and dominated by the Communists. The domination and control of Poland from the Kremlin was accompanied with a change in political parties and ideologies, and as such the Communist party gained popularity. In Poland this was manifested as the 'Polish United Workers Party' which was established in 1948 as the Socialist Party merged with the Communists. All other political organisations were dissolved which meant Poland was a one Party state, chiefly ruled under the dictatorship of Stalin until 1956 (Syrop, 1976).

The government strategy of 'Socialisation,' where the economy was viewed from an overall rational approach, was implemented with the Soviet's desire to have complete control over the economy (Laird, Hajda and Laird, 1977; and Turnock, 1978). State planning was delivered through medium-term comprehensive, mandatory programmes (ranging from 3 to 5 years) which laid down production targets and instigated levels of investment to different sectors and projects. Capital spending was dictated by political fiat in a command system that valued heavy industry because of the military implications, to the neglect of consumer needs. A greater emphasis was placed on the production of raw materials coupled with the reorientation of trade from Western Europe to the Soviet Union (Turnock, 1978; Sachs, 1992; and Hercynski, 1993).

Over the four decades after the Second World War, the Polish economy became increasingly imbalanced. Being highly integrated with the rest of the national economy, agriculture could not avoid these problems, as it was dependent on the other sectors whilst governed by the command economy. The government's agricultural policy, which aimed at ending private farm

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[57]Land was provided to 572, 000 peasant families from Byelorussia and West Ukraine (Turnock, 1978).

ownership, compounded the situation. During 1951-1955, the annual growth rate of private farming was negative (-1.5 per cent), but between 1956-1965, it remained high and positive (5.6 per cent) when the Polish authorities recognised its mistakes of the preceding era and stopped forced collectivisation. During 1966-1970, the government again restricted land movements within the private sector and access of private farmers to inputs; the corresponding annual growth rate fell to 1.3 per cent. Changes in agricultural policy in 1970-1, followed by the increase in industrial and agricultural inputs raised the growth rates on private farms (2.3 per cent) once more. However, the government stressed the role of the socialised sector and further attempts were made to develop and strengthen co-operative farming between 1976-80. As such, the annual growth rate of the private sector declined to -2.5 per cent during this period. In contrast, the state sector had positive annual growth rates throughout the entire period[58] (Florkowski, Hill and Zareba, 1988). Although farm inputs (seed, fertiliser, fuel and machines) were in short supply, (like most manufactured goods), a large part of those farm inputs that were available went to the state and cooperative sectors, which were less efficient and less flexible than private-sector farms. Profitability or efficiency were not of primary importance; the overriding objective focused on physical increases in production (i.e. meeting quotas set by the government) which were met via heavy subsidisation, price supports, and guaranteed sale of produce. Such overt discrimination was designed to accelerate the incorporation of private farms into either the cooperatives or the state sector (Pacione, 1986; Klodzinski, 1992; and Ash, 1992).

However Poland's agricultural sector remained 'unique' amongst the Soviet bloc (Bylinski, 1990) as it was

> "..the only nation among COMECON members whose government was unable to collectivise its members...They preferred owning land to losing their independence and defiance of collectivisation was indicative of the farm sector's resilience.." (Shen, 1992: 163).

As a result, from 1945-1989, the size of the socialised agricultural sector never reached its planned level under the Communist regime and as such, the average size of individual private farms in Poland has changed very little over the last thirty years (Dunman, 1975; Laird, Hajda and

[58]Between 1950-55, its annual growth rate was 9.4 per cent falling to 0.5 per cent during 1956-60. Between 1961-65, it rose to 5.8 per cent declining to 4.5 per cent during 1966-70. It increased to 7.9 per cent during 1971-1975 but fell to 0.6 and 0.2 per cent between 1976-80 and 1981-83 (Florkowski, Hill and Zareba, 1988).

Laird, 1977; Ilbery, 1986; and Agra Europe, Special Report No. 56, 1990). Despite the desired emphasis on government ownership and central control of large scale farms, the smaller farms and peasant holdings continued to survive. As a result, farms of different organisational forms producing similar outputs in the same locations functioned simultaneously (Wos interview, 1993).

During the 1980s, the Polish economy gradually began to move towards a market based economy[59], chiefly because of poor competitiveness in international trade[60] and a high marginal propensity to import (see section 2.5.2), and so agricultural policy was modified to recognise the superior performance of the private sector. Thus, the position of Polish agriculture improved significantly during this period and self sufficiency ratios increased for many agricultural commodities. The government amended the Constitution to guarantee the permanence of private farm ownership and heavy capital investment ensued (Agra Europe Special Report No. 56, 1990; Klodzinski, 1992; and Ash, 1992). Furthermore, in July 1981, an attempt was made to eliminate state subsidies to socialised organisations in the agricultural sector. In general, credits, taxes and subsidies began to be applied uniformly to both sectors (Gemma, 1989). In the following year, economic reform emphasising autonomy and self finance was targeted at state sector enterprises. This meant that the socialised farms were authorised to make their own decisions on the size and line of production (Gemma, 1989).

The production and marketing relationships which have been borne out of a centrally planned system has meant the development of the agricultural sector, today, is fraught with difficulties. As Poland and other Central and East European Countries (CEECs) attempt to shed the remnants of communist governance, they struggle with the process of adjusting to a Western-style democracy with a 'market orientated system'. The shift to a capitalist framework has not been instantaneous. The economic reconstruction, establishment of private property rights, promotion

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[59]In 1986, the market reforms that had been implemented in the early 1980s were deemed a policy failure by General Jaruzelski, leader of the communist government. Their failure, together with internal pressure and political changes in the Former Soviet Union (FSU) led to a 'Second Stage of Economic Reform' and the 'Realisation Programme of the Second Stage of Economic Reform' during 1987-89. This programme included cuts in subsidies and drastic price increases in the consumer markets, especially in food.
At the beginning of 1989, several steps towards economic and political reform were taken as the 'Round Table Talks' between Solidarity and Poland's communist government were leading towards a compromise for partially free elections and a far reaching economic reform. Finally in June 1989, Solidarity's victory in the elections tipped the balance of power and plans for major economic change ensued (Kwiecinski and Quaisser, 1993).

[60]By the end of 1975, Poland's debt to Western countries was 6, 000 million US dollars (Turnock, 1978).

of competition, behavioural change of economic agents[61] and the reintegration of these countries, both politically and economically, back into 'Europe' and the 'world economy' is proving problematic, to say the least (von Witzke, 1993; refer also to 7.2.3).

Since 1989, successive Polish governments have showed an overriding commitment to the economic transformation and restructuring of the Polish economy and have implemented a variety of policy instruments. Poland adopted the 'Big Bang' approach to economic transition, worked out in consultation with the International Monetary Fund (IMF) (detailed earlier in section 1.1). This required a reduction in subsidisation to all economic sectors, state de-monopolisation, currency devaluation[62], secured foreign loans in an attempt to curb inflation[63] and restrictive incomes and monetary policies. Furthermore, the installation of a new institutional framework is designed to reduce debt, reform the prevailing financial system and guarantee stability, prosperity and economic growth. The elections of September 1993 and 1995[64], resulted in the re-election of former 'communist'[65] parties with a commitment to a mixed economy, recognising the importance of the welfare system (East European Reporter, 1991; Winiecki, 1992; Kwiecinski and Quaisser, 1993; The Spectator, 1993; and East European Markets, 1993-6).

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[61]As evident from primary research carried out in Wagry and Rzgow (1993/4):
"..Farmers must find a market..A change in mentality is required.." (Nowak interview, 1993).

[62]The Polish zloty was devalued on 27 August 1993 by an average of 8 per cent against a basket of western currencies (East European Markets, 1993).

[63]In 1989, inflation was 244.1 per cent, rising to 584.7 per cent in 1990, declining to 70.3 per cent in 1991, 43.0 per cent in 1992 and 36.9 per cent in 1993. By 1994, it had fallen to 22 per cent and is forecast at 19 and 13 per cent in 1996 and 1997 (Sources: Economic Survey of Europe in 1993-1994 (Geneva: Economic Commission for Europe, UN) from K. Poznanski: 25; East European Markets, June 1996; and Reuter, July 1996).

[64]Since 'Solidarity' aided the collapse of the one-party system at the end of the 1970s and early 1980s, numerous political parties have evolved.

[65]A coalition government comprising of the Left Democratic Alliance (SLD), former communists, and the Peoples Peasant Party (PSL) was elected to power in October 1993 with Waldemar Pawlak formally appointed new Prime Minister. On 20 November 1995, Alexander Kwasniewski, a former communist wins the elections and on 31 January 1996, Wlodzimierz Cimoszewicz was nominated as new Polish prime minister (East European Markets, 1993-6).

2.5 Polish Agrarian Response to Economic Transition (see also Chapters 5, 6 and 7)

2.5.1 Marketisation

As a first step towards marketisation, agricultural prices were almost completely liberalised on 1 August 1989 by the first non-Communist prime minister, Tadeusz Mazowiecki (Ash, 1992). In practice, this meant that agricultural products and farm inputs supplies were no longer subject to price controls. The change to a free-market food economy, at a time when the other sectors in the economy remained strongly centralised, created economic disorder. It was evident not only in farming, but also in the other related sectors (for example, food processing) which were largely dominated by (former) state monopolies and consequently with little competition between suppliers or buyers. Newer associated complications arose in the inter-regional wholesale markets[66], following the collapse of the monopolistic trade and distribution networks in 1990, making it difficult for farmers to sell all their output, as they had been able to do so in the past (Slay, 1994). Whilst, the initial intention of the introduction of the free market system was to improve the farmers economic situation, in the short run, it made it worse (Klodzinski, 1992; Ash, 1992; Kwiecinski and Quaisser, 1993; and Portugal, 1995). The primary objective of transforming to a more market orientated economy had been to sift out the small, less efficient farms, creating larger, more productive units comparable with those in the United Kingdom, Germany or The Netherlands.[67] To date, the changes in this respect have been minimal (Slay, 1994; and GUS, 1994).

In the three months immediately following agricultural price liberalisation, (1 August 1989), Polish agricultural and food prices increased substantially. The rise in prices was coupled with a decrease in the supplies of food to the market. With inflation running at 50-60 per cent monthly, farmers were encouraged to hold onto agricultural production, in anticipation of future price rises (Nowak interviews, 1993/4). Two alternative scenarios may explain this phenomenon: first, the behaviour of monopolistic food industries, which, with prices freed, were able to earn monopoly rents from lower output and higher prices and second, that there was simply a time lag

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[66]According to primary research carried out during Phase III (October-December 1994), the absence of wholesale markets is one of the gravest problems facing Polish agriculture. Consequently, one has been developed in Poznan (funded by Swiss foreign assistance) and four additional wholesale markets were planned for the year 1995. Their development is attuned with projects under Agricultural Sector Adjustment Programme (ASAP), a branch of the central government, funded by the World Bank (Borek, Smith and Hughes interviews, 1994).

[67]In 1993, the average size of a British, German and Dutch farm was 67, 28 and 16 hectares respectively (Eurostat, 1995).

between the decisions by farmers to react to high prices and supply the market and their actual physical production capability to react (Ash, 1992). The consumers response to price liberalisation is synonymous with the 'giffen good' paradox: as food prices rose, demand for food increased. Perhaps, this was because people began to stockpile during the period of hyperinflation as prices were considered relatively low in comparison with the possible future price increases (Ash, 1992; and Nowak interviews, 1993/4).

The largest shock to the agricultural sector, however, came after the macroeconomic Stabilisation programme (the 'Balcerowicz plan') was introduced on 1 January 1990 principally to halt this hyperinflation. The economic slowdown, illustrated by the fall in real wages and the decrease in consumer spending power, resulted in a fall in Gross Domestic Product (GDP)[68] by 12 per cent[69] and a 20 per cent fall in the demand for food. Due to the nature of agricultural markets and the delay between production and consumption, there is always a time lag between the forces of supply and demand. Although the demand for food fell in 1990, the output level in 1990 remained high. The supply side response was not fully felt until 1991 and 1992, with arable output at its lowest level during the six year period (refer to sections 5.5.1.1 and 6.5). Moreover, the problem was aggravated by the fact that food subsidies were cut significantly from a previous level of 4 per cent of GDP in 1989 to only 0.4 percent of GDP in 1990 under IMF recommendations (Ash, 1992; and Kwiecinski and Quaisser, 1993).

The decline in food demand associated with macroeconomic stabilisation resulted in huge surpluses of agricultural production which put downward pressure on agricultural prices. For example, the price of food products in April 1991 were at the same level as in January 1990. For some products, such as potatoes, sugar and fruit, prices declined to 50-60 per cent of their January 1990 level and for meat products, and tea and coffee, prices fell 15 per cent below the January 1990 level (Karp and Stefanou, 1991). The net effect on the agricultural community, was farmers being subjected to a cost-price squeeze. As the prices of inputs increased by 800 per cent, the product prices paid to farmers increased by only 400 per cent over the 1990-1991 period.

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[68]Estimation of macroeconomic data relating to post socialist countries may be unreliable (documented in section 5.2).

[69]In 1990, GDP fell by 12 per cent. By 1991, it had recovered slightly to -8.6 per cent and in 1992 and 1993, it had risen to 1.5 per cent and 3.8 per cent respectively. By 1994 and 1995, economic growth rates increased to 4.3 and 7 per cent per annum with the prospective growth rate for 1996 at approximately 5.5 per cent (World Outlook, 1995; Polish Hearth Club Conference, 1995; and East European Markets, 1996).

Profit margins and farm incomes fell significantly. For example, the number of quintals of wheat required to purchase an 'Ursus' tractor increased from 248 in the last quarter of 1989 to 618 in the third quarter of 1991 (East European Agriculture, 1992; and Szemberg, 1992c). The extent of the decline in farm incomes was so great that, according to Gabriel Janowski, Mininster of Agriculture in the Olszewski and Suchocka governments, farm incomes in mid-1992 had fallen to 40 per cent of their 1989 levels (Slay, 1994). Moreover, the gap between industrial and agricultural wages increased from 9.9 per cent in the first quarter of 1990 to 20.5 per cent by the same period in 1991. The average farm income in Poland was some 60 per cent of that of workers in the industrial or service sectors (GUS, 1993b).

In response to their mounting costs and falling farm incomes, farmers drastically reduced their purchases of inputs (Ash, 1992; Wos and Anuszewski interviews, 1993). Between 1988 and 1993, the total volume of artificial fertilisers applied to the land fell by 81.3 per cent; the largest annual decline (34.0 per cent) occurring between 1991 and 1992 (GUS, various issues; see Figure 2.1, above and section 5.5.3.2). The corresponding value for the application of pesticides fell by more than two thirds. The increase of input costs meant a reduction in farmer's purchasing power and a simultaneous fall in the demand for artificial fertilisers.[70] Between 1988 and 1991, the price of nitrogen fertilisers rose 60 fold, phosphorus 96 fold and potash 115 fold. The corresponding wheat prices only rose 13 fold. Insofar as environmental benefits are concerned, a reduction in the

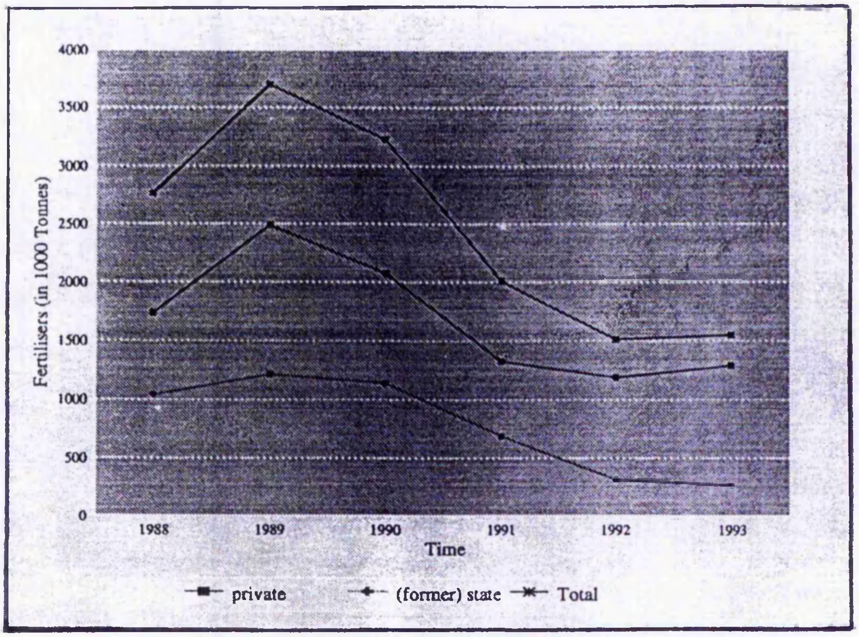

Figure 2.1: Fertiliser Usage during Polish Economic Transition, 1988-1993 [Source: GUS Publications, var. issues].

[70]It is likely that farmers would have increased their use of home-produced manure to compensate for the rise in prices of artificial fertilisers. However, it is impossible to account for the substitution of inputs simply because data relating to this variable do not exist (detailed in section 5.5.3).

application of man-made fertilisers and pesticides is likely to limit land, soil and river pollution, with greater emphasis on 'organic' farming. However, from economic and social perspectives, productivity was significantly impaired in the early transition years (Ash, 1992).

Sales in agricultural machinery generally declined over the transition period (1988-1993) as well. Whilst purchases of grain sowing machines declined by 52 per cent, the demand for milking machines fell by 57 per cent during 1990-1991, partly due to the fall in livestock production. Tractors operating in the private sector over the same period showed signs of stabilisation[71] (Szemberg interview, 1994), but operative capital in the (former) state sector in 1993 was 60.1 per cent lower than its 1988 level (refer to Figure 2.2 above, and section 5.5.3.1). There are shortages of different kinds of farming machines, especially tillage sets, sowers, cutters, potato and sugar-beet combines, corn harvesting machines, specialised trailers, motor tools and a large group of machines and equipment for the mechanisation of animal production (MAF, 1992). Other associated problems, lie with the ability and availability of repair work and spare parts. Furthermore, the machinery is sometimes ill-suited to the plots of land (i.e. too big for the land strips)[72] (Farmer interviews, Wagry, 1993/4). The end result has been machinery left abandoned (Szemberg interview, 1994). Indeed, it is unlikely that Polish farm mechanisation will intensify during the forthcoming period

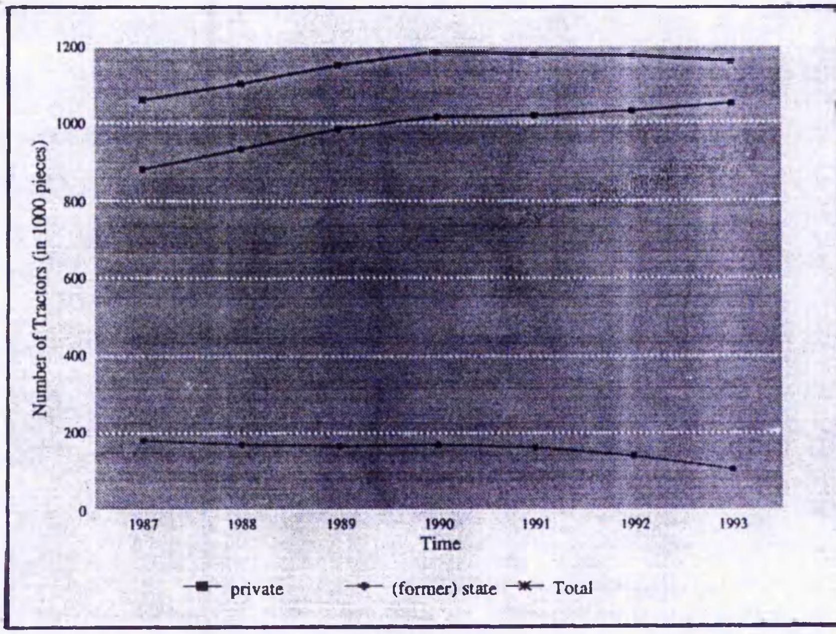

Figure 2.2: Operative Capital during Polish Economic Transition, 1987-1993 [Source: GUS Publications, var. issues].

[71]Whilst private sector operative tractors increased by 51, 900 during 1987-8, the corresponding increase was only 15, 800 during 1992-3. Whilst, there were 6.14 cultivated hectares per tractor in 1988, this figure had fallen to 7.02 cultivated hectares by 1993 (see Table V.1, Appendix V).

[72]This problem is particularly acute in the southeast, where private sector agricultural holdings are characteristically small. The average size of a south eastern private farm was 5.1 hectares during 1988-1993 (see section 5.4.2).

(detailed in section 7.3.3), hampering Poland's rural development even further[73] (Klodzinski, 1992). Inevitably, the agrarian response had a devastating effect on agri-business and the food processing industries dependent upon the primary sector.

As part of the 'Balcerowicz Plan', the zloty was devalued on several occasions over the 1990 to 1991 period and a new currency was introduced in January 1995 (1000 zloty became 1 zloty). The initial response was a substantial increase in the value of agricultural exports from Poland to the EU, which is now one of the main recipients of produce from Central and Eastern Europe (CEE) to date. According to one source, Polish exports of food and agricultural products in 1990, increased by 22.4 and 77.4 per cent respectively, in volume terms. For 1991, agricultural exports were up 25.5 per cent, in volume terms, while food exports were up 3 per cent in value terms (Slay, 1994). However, the so-called liberal[74] terms of trade in the 'Associate Agreement Between Poland and the European Community (EC) (signed 31 December 1991)'[75], have resulted in asymmetrical trade flows[76], to the extent that EU agricultural exports to Poland are in fact much higher than either Polish politicians or economists had ever imagined (Wierczorek interview, 1994). Between 1990 and 1991, Polish agricultural exports to the EU increased marginally, by 0.9 per cent, whereas agricultural imports rose by 4.3 per cent (MAF, 1992). By 1994, the situation had worsened with a registered budget deficit of more than 100 million dollars out of its agricultural trade with the EU, principally because of the decline in competitiveness of CEE, liberalisation of imports, lowering of tariffs and abolition of many quotas (Reuter, June 1995).

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[73]It is cited as being technologically 25 years behind post-industrialised countries (Klodzinski, 1992).

[74]There are and have been trade restrictions on certain industrial and farming products. For example, rapeseed oil, cherries, beef and lamb (Bremon interview, 1994; and BBC Production, 1994).

[75] (i) The Agreements have a wide coverage. They consist in 124 Articles dealing with political dialogue and general principles (Articles 1-6), movement of goods (Articles 7-36), movement of workers, establishment, and supply of services (Articles 37-58), payments and capital, competition and approximation of laws (Articles 59-69), economic, cultural and financial cooperation (Articles 70-103) and final provisions (Articles 102-124). Moreover they are accompanied by 18 Annexes and 7 Protocols. The EC Agreements with Hungary, Poland and the Czech and Slovak Federal Republics are similar (Messerlin, 1993).

(ii) The trade provisions were implemented on 1st March 1992 and the Agreement came fully into force in February 1994 providing over 10 years for the progressive establishment of a free trade area and for the abolition of customs duties in trade between the EU and Poland (Reuter, February 1996).

[76]It has taken less than five years for the EU to move into a dominant trading position in the foreign trade with CEE (Slay, 1994).

However, exports from CEE to the west are still limited by a number of factors[77]; difficulty in meeting western standards on quality; and heavily subsidised imports from the west, usually valued-added goods ready for consumption (Kuba, 1996). Some of Poland's domestic surplus production in 1995 were exported to the EU in an effort to offset the trade imbalance, but Polish agricultural and food products still only account for 1 per cent of EU imports (Reuter, February 1996). Consequently, the Polish domestic market has been and is continuously inundated with higher quality, heavily subsidised imports especially from Germany and The Netherlands[78] which are undercutting Polish domestic prices (Rowinski, 1991; Schamel, 1991; Szafarz, 1991; Smith, Wierczorek, and Rowinski interviews, 1994; and Reuter, August 1995).

Generally speaking, EU trade barriers to CEE agricultural produce were reduced by 50 per cent up to 1995, and in accordance with the General Agreement on Trade and Tariffs (GATT), it is envisaged that trade restrictions will be steadily reduced until 2000 (Ash, 1992; Rowinski, 1993; Niemczyk, 1993; Rowinski, Bremon, Butt and Wierczorek interviews, 1994; and Tangermann seminar, 1994). However, trade liberalisation in agricultural goods remains 'embryonic and uncertain' (Messerlin, 1993: 120). Although the expansion of preferential quotas for agricultural and food products would help CEE without harming the EU farmers, there is a distinct bias towards a number of industrial products[79] in the EU-CEE trade agreements (Butt and Bremon interviews, 1994; Tangermann, Josling and Munch, 1994).

One final point to be made is that Polish farmers are not yet maximising their EU quotas. Kwiecinski (1994) reports that in 1992 Poland filled its preferential quotas for only 30 per cent of the products subject to quotas. The reasons for not utilising the quota fully are many. First, the decline in agricultural production due to economic restructuring (documented in Chapters 5 and 6). Second, the quotas are partly based on historic patterns of trade when the CEECs were tied to the Comecon trading bloc. These patterns do not necessarily reflect each country's comparative

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[77]The Agreements themselves are loaded with provisions on rule-making particularly export quotas, safeguards and rules of origin-which foreshadow managed trade, undermine the announced liberalisation, and underline the failure of the EC to act as the constitutional anchor for economically sound trade disciplines in Europe (Messerlin, 1993).

[78]Due to better food processing skills, including packaging, marketing and promotions (Wos interview, 1993).

[79]The major 'Partners in Transition' industrial exports (apparel, steel, coal) are however still facing substantial EC tariffs and non-tariff barriers and are likely to continue to do so until 1997 (Messerlin, 1993).

advantage.[80] Third, the preferential quotas may not appeal to farmers because of the unavoidable bureaucratic procedures involved. Fourth, the costs of requesting a quota may exceed the expected benefit. Kwiecinski (1994) also indicates that quotas were often allocated to EU importers and not Polish exporters so the decision on whether the quota is to be utilised is not strictly within the Polish domain (Reed and Kwiecinski interviews, 1994; and Haynes, Buckwell and Courboin, 1994; subsequent documentation in 2.5.2).

In summary, the Polish rural community's experience of economic reform has been disappointing. The farmers have been hampered by the marketisation process, with uncertainty from both the product and input markets. Having been subjected to a cost-price squeeze coupled with a particularly severe dry summer in 1992, total agricultural production fell by 12 per cent in 1991-2. During 1992-3, although crop production rose by 15 per cent, animal stocks fell by 12 per cent[81] (Reuter, January 1994; and Kuba, 1996). This translates to a 14 per cent decline on average figures for 1986-1990 (MAF, 1993; and Kuba, 1996). The greatest fall in aggregate (private and former state) cereal production between 1991-1992 occurred in the north and western areas of Poland[82] (MAF, 1993; refer also to sections 5.4.2 and 6.5). The farmers, themselves are very sceptical of any future economic plans and are finding it difficult to survive under present conditions (Farmer interviews, Wagry and Rzgow, 1993/4). The situation is hampered further by high levels of registered and hidden unemployment in the agricultural

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[80]For example, Bulgaria exported substantial amounts of cigarettes to the Former Soviet Union (FSU) because this was one of its designated functions under the Comecon system. Bulgaria had never been a large grain exporter. However, under new market conditions, it is likely that grain exports will become increasingly important, because of the comparative advantage of this produce (Haynes, Buckwell and Courboin, 1994).

[81]Polish harvest production increased by 10-15 per cent in 1994-5 (Reuter, August 1996).

[82]In the voivodships (counties) of Koszalin, Slupsk, Szczecin, Gorzow Wielkopolski, Pila, Poznan, Zielona Gora, Kalisz and Konin (MAF, 1993).

regions. The problem is particularly acute (as high as 34 per cent) in the regions where the (former) state sector dominated (Szemberg interview, 1994; subsequent documentation in section 7.5.3). Shedding of the (former) socialist workforce is related to institutional change in private property rights.

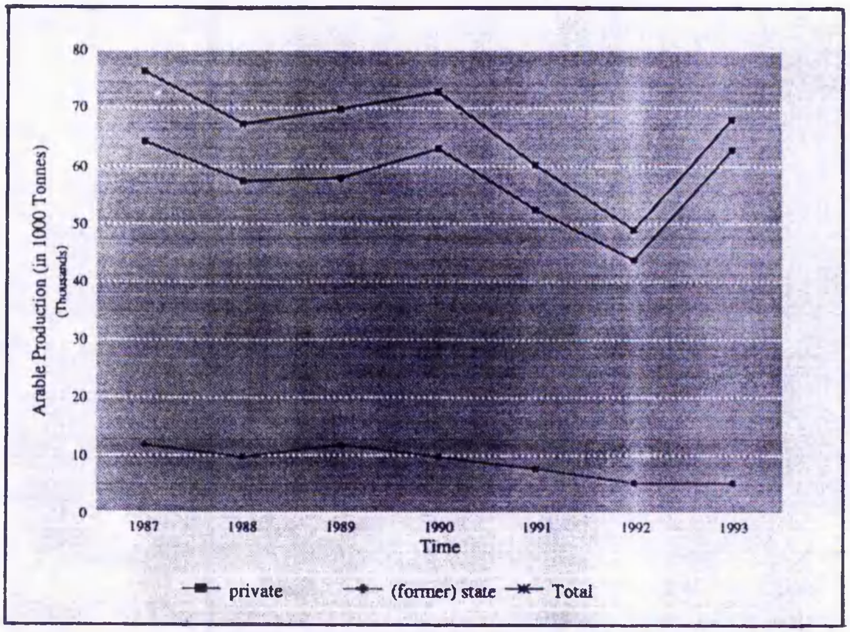

Figure 2.3: Arable Production during Polish Economic Transition, 1987-1993 [Source: GUS Publications, var. issues].

Privatisation of (former) state agriculture has meant the replacement of fixed-wage contracts with fixed-rent contracts and sole ownership (hypothesised in section 1.5). Moreover, the continued uncertainty about reprivatisation and regulation of land sales as well as the fate of cooperative and state farms has also hung over the formulation of agricultural policies (detailed also in 2.5.3 and 7.2.3). The political instability which is not only characteristic of transitional economies[83] but was particularly prevalent during 1989-1992, only aggravated the problems facing Polish farmers (Reed, Hughes and Farmer interviews, Wagry and Rzgow, 1993/4) and created an environment of risk and uncertainty which is impeding economic growth (Duczkowska-Malysz and Duczkowska-Piasecka, 1988; and van Zon, 1992).

Owing to economic reform and the world recession, manufacturing industries have been forced to make redundancies and professional or semi-professionals are returning to the countryside where dual employment is very important (Szemberg interview, 1994; further documentation in 5.5.1.1 and 7.5.3). This is ultimately hindering both the economic and social development paths of the rural communities (Wos and Farmer interviews, Wagry and Rzgow, 1993/4). However, the overriding concern expressed by all leading academics has been twofold:

[83]By 1994, the political environment had marginally stabilised under Prime Minister Pawlak of the coaliton government (the SLD and the PSL) (Kasriel, 1995).

first, the total fall in use of inputs (e.g. fertilisers, pesticides and seeds, as depicted earlier in Figure 2.1) and secondly, the fall in both cereal (see Figure 2.3) and animal production[84] (Wos, Anuszewski, Borek, Rowinski, Reed and Szemberg interviews, 1993/4). According to data released by GUS in 1992, the level of production for crops (cereals, potatoes, sugar-beets, oil plants and meadow plants) over the 1991-2 harvest period fell (see section 5.5.1.1). This has affected the procurement process where, for example, the procurement of wheat declined by 36.6 per cent and of rye by 62 per cent, whilst the procurement of potatoes decreased by 22 per cent in the July-December period of 1991 and 1992. At the same time, the prices in the market places of basic agricultural products, such as wheat and potatoes had increased between December 1991 and 1992 by 177 and 121 per cent respectively (GUS, 1993b).

2.5.2 Trade and EU Membership

Poland is self sufficient in all major crops, and is one of the world's largest producers of potatoes, vegetables and fruit and presently has one of the highest economic growth rates of all European countries (Agra Europe Special Report No.56, 1990; and East European Markets, June 1996). However, with the collapse of the Council of Mutual Economic Assistance, former Comecon markets and trading links with the FSU, which imported a large percentage of Polish produce[85], Poland is faced with a new set of alternative scenarios. To sustain and increase its level of agricultural trade competitiveness, Poland must respond in two distinct ways. First, it is essential to develop its food processing and marketing industries. The 'lack of suitable packaging, high cost of raw materials, weak marketing and promotion of exports, and a poor image of agricultural export specialities' have been cited as the major obstacle to Poland's relatively low share of world trade (Agra Europe, Special Report No.56, 1990: 35). Second, it is vital that old trade routes with the former communist countries are rejuvenated[86], existing ones expanded (other 'Partners in

[84]In animal production, the use of industrial fodders was dramatically cut down, veterinary services were reduced and there was an intensive culling of the basic herd. The number of big heads per 100 hectares of farmland in state farms (ppgrs) fell from 58 in 1990 to 42 in 1992. Livestock fell from 46 to 30, pigs from 127 to 115 and sheep from 33 to 12 head (APA, 1994: 15).

[85]For example, in 1975, 56.6 per cent of Poland's exports went to the Soviet Union, but by 1989, this figure had fallen to 34.8 per cent (Lavigne, 1995: 258).

[86]The Central European Free Trade Area (CEFTA), an interregional cooperation was established on 21 December 1992 and came into force on 1 March 1993. Member countries include Poland, Hungary and the Federal Czech and Slovak Republics. CEFTA has since been enlarged to include Slowenia.

Transition'[87], the countries of the European Free Trade Association (EFTA) and the EC), and new markets opened (Sunrise economies) in order to soak up surplus domestic production (Ash, 1992; Wos, Anuszewski, Rowinski and Borek interviews, 1993/4).

After the signing of the 'Europe Agreement (1991)', nearly 85 per cent[88] of Poland's total agricultural exports by value were sent to the Western countries in 1991; the main recipients being Germany and France (MAF, 1992). The 'Partners in Transition' hope to begin talks for full EU Membership (2002/3) after the Inter-Governmental Conference (IGC) in mid-1998, when negotiations commence with Malta and Cyprus (Reuter, June 1996; and East European Markets, August 1996). However, based upon the fact that the European Commission has already ruled out the prospect of significant budget increases to absorb CEE[89], it is likely that EU expansion eastwards will take much longer, in reality.[90] Full EU accession is likely to result in both the collapse (or at least major reforms) of the Common Agricultural Policy (CAP) in its present form and additional substantial strain on EU structural funds.[91] In light of the GATT agreement (2000), a general reduction in protectionist policies for agriculture is essential (Bremon, Butt, Wierczorek interviews, 1994; and Tangermann seminar, 1994). Whilst the prospect of Poland and other CEECs being welcomed economically into the EU is highly unlikely, it is, nevertheless, a political inevitability (Ash, 1992; Rowinski, 1993; and Niemczyk, 1993).

An alternative strategy suggested by leading Polish academics is to expand existing markets in the Middle East. However, political tensions and global policy may hinder any mutual economic activity. Alternatively, a more pragmatic approach would be to create new trading links

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[87]On 10 August 1995, Roman Jagielinski and Josef Lux, Polish and Czech agricultural ministers signed an agreement on further co-operation in agriculture, liberalising agricultural trade between Poland and the Czech Republic and veterinary and plant protection. The three-tiered trade agreements include one-third of products with zero custom duties, products for which duties will be lowered between 1st January and 31st December 1997, and 'sensitive' items, i.e. those products which both parties agree there is no will to lower the duty (Reuter, August 1995).

[88]The EU is presently the main trade partner of Poland: in the first half of 1995, it accounted for 71 per cent of total Polish exports and 64 per cent of total Polish imports, almost half of this trade involving Germany (Reuter, January 1996).

[89]An internal review concluded that it would be financially and politically impossible to offer equal grounds on levels of regional aid for future EU members as the existing poorer members of the Union (Barber, 1995).

[90]According to the Centre for Economic Policy Research, it may be as long as two decades before full accession is granted (Baldwin, 1992).

[91] (i) Despite the recent addition of Austria, Finland and Sweden (1995), which are countries representative of EFTA, and are net contributors to the EU.

(ii) Structural funds also known as 'Regional aid' accounts for a third of the EU's budget and is intended to help weaker member states cope with the single market (Barber, 1995).

with the 'Asian tigers', such as Taiwan, Singapore, Korea and Thailand, who import between 70 and 75 per cent of their food requirements. The opportunity for mutual exchange exists, Poland requires technology, whereas these countries need staple food products, such as, meat, cereals, and milk powder (Wos interview, 1993).

2.5.3 Privatisation (refer to sections 1.4.1.1 and 7.2.3)

Economic transformation to a market economy prescribes the establishment of private property rights.[92] Several strategies have been pursued to place land in private ownership and/or operation across CEE, the Commonwealth of Independent States (CIS) and the New Independent States (NIS). The most important in CEE has been the restitution[93] or compensation of former landowners. For example, the authorities in Bulgaria have sought to return specific parcels of land to their original owners. Hungary, on the other hand, adopted a voucher scheme which entitled the holder to bid for land, instead of physical reimbursement. Mass or 'spontaneous' privatisation usually to former state sector employees, without reference to former ownership, have been the most popular approaches in Albania, Romania, the Baltic States and even in the NIS. However, another popular method in the NIS, includes local authorities allocating land to individuals which was formerly unused or was an under-exploited part of a larger farm. Private farms began to operate simultaneously on compensated land or with a share from a former collective farm (Kuba, 1996). Privatisation of the socialised farming sector has resulted in the development of various types of farms. For example, in Hungary and the Federal Czech Republic, large scale state and collective farms have been replaced with co-operatives; whilst in Estonia, Romania and the NIS, corporate or joint-stock companies have been preferred (Kuba, 1996).

Unlike the primary sectors of other CEE countries and the NIS, the Polish private agricultural sector retained its dominant position throughout the communist years, accounting for about 78 per cent of the total agricultural output per annum (GUS, 1992f; and Wos interview, 1993; detailed earlier in 2.4). Moreover, during 1987-1993, the private sector produced over 87 per cent of all major arable crops (see also 5.5.1.1). In contrast, the (former) state sector, which owned 18.4 per cent of the farmland in 1986 produced on average 17 per cent of the total

[92]Detailed in 1.4.1.1.

[93]The successful restoration of property rights in all former Communist countries has been impeded by the poor state of pre-communist land-registration records, an insufficient legal framework and many rightful owners deficient in the farming or managerial skills required for agriculture (Marszal interviews, 1993/4; and Kuba, 1996).

agricultural production. The average size of a (former) state-owned farm was 2713 hectares and 86 per cent of them were located in the northern and western regions of Poland where the land is of higher quality (Dawson, 1982; Agra Europe, Special Report No. 56, 1990; and Nowak interviews, 1993/4; refer to 5.4.1, 5.4.2, and Table V.2, Appendix V). As a result of the centrally planned system, the farms, although possessing the highest level of technology available and fed with government subsidies, nevertheless were inefficient and costly. The present situation reflects the legacy of the past thirty years.

In 1990, the Polish government established 'The Agricultural Property Agency of the State Treasury' (APA)[94] to dispose of the socialised farming sector. The main objective of the government's medium term structural adjustment policy was to develop a market for private land transactions and leasing, and to privatise state farms, so as to create a structure of farms that will be able to compete on the international market (Portugal, 1995). The APA subdivided the total former state-owned areas into 15 regional departments and each regional office makes an autonomous decision on its disposal[95] (Choynowoki interview, 1993; and APA, 1994). Director Choynowoki of the APA in Lodz, outlined the functions of his department:

> "..Firstly, the Voivod[96] liquidates previously state owned farms and holds them in the accounts. The Agency takes control of these farms from the Voivod and prepares them for future activity. The Agency decides their fate, whether it is sale or lease, separation or combined to create larger units. Their underlying concerns are the economic consequences on the area, for example, regional unemployment[97], and as such are cautious not to divide too much.." (Choynowoki interview, 1994).

In addition, the agency provides some financial assistance to prospective buyers, by providing credits and loans at low real interest rates (40-45 % in 1993) with an extended pay back period. Furthermore, special concessions have been granted to former state farm employees who were

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[94]The APA began privatising state farms on 1 January 1992.

[95]According to the APA Report, ways of disposal include: sale of farms, plots of land and other assets; giving the assets over, for a specified period, for non-gratuitous utilisation (lease or tenancy); contributing the assets into companies, created either only by the Agency or with other partners; entrusting the property to State organisational entities without legal personalities for management; or entrusting the property to an administrator designated by the Agency for a specified period (APA, 1994: 4; see also Table V.1, Appendix V).

[96]The 'Voivod' is the governor of the voivodship (county).

[97]The unemployment rate in the city of Lodz is one of the highest in Poland (20 per cent in 1992) because economic reforms meant the closure of a substantial number of unprofitable factories.

made redundant during state sector transformation. Another factor halting the farm's adjustment process to the market economy, and at the same time slowing down the Agency's activities with regard to the ownership transformation in agriculture, has been the insufficient development of infrastructure and of institutions dealing with agriculture. An inadequate legal framework for the reprivatisation process, underdeveloped land markets together with debts exceeding the value of the property itself has also led to a cautious application of the privatisation programme and impeded the divestitude of state farms (Rozwadowski, 1991; Portugal, 1995; and Kuba, 1996). The waiting time of several months to establish or transfer the ownership title, to organise the land register, and to determine the size or location of the plot have rendered trading in agricultural real estate difficult (APA, 1994). Furthermore, the location of the state land resources is in the most part too far away from the private farms to allow them to expand (Portugal, 1995).

By the end of July 1994, the APA had taken control of assets comprising almost 4 million hectares of land and over a quarter of a million of flats. This translates as 500 of the 800 state-owned farms (Nowak interviews, 1993/4). Despite the recognition of 'family farms as the main component of organisational space on which agricultural production is being run' (APA, 1994: 8) and the commitment of the Agricultural Property Stock to contribute to the enlargement of the existing, as well as the creation of new, family farms, yet only 6 per cent of all state land had been sold outright or given away free of charge to private farmers, 41 per cent leased and 53 per cent remained under the control of the APA.[98] The continued uncertainty about reprivatisation and regulation of land sales is hindering further development of private Polish agriculture (Reed and Hughes interviews, 1994; and Farmer interviews, Wagry and Rzgow, 1993/4). Moreover, indecision from central authorities has exacerbated instability at the regional levels:

> "..Two big brother neighbours (Germany and Russia), everything depends on them. The past has been dogged with uncertainty. Lodz has high unemployment. People who are ruling are now incompetent, where cherries are left on trees, EC imports should be reduced.." (Interview with Farming Intermediary, Rzgow, 1993).

> (There is).."Apathy towards government and much uncertainty. (People)..only see price rises and wage stagnation.." (Choynowoki interview, 1993).

The future of the state farming sector is less optimistic than the private sector of Polish agriculture

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[98]Ash, 1992; Choynowoki and Nowak interviews, 1993/4; APA, 1994: 2; Portugal, 1995; refer also to sections 5.4.1 and 7.2.3, and Table VI.1, Appendix VI.

because of its structural nature[99] and, to a larger extent, its dependence on the socio-economic conditions under which the privatisation process is being implemented. In 1992, as well as in 1993, those conditions remained unfavourable. Moreover, despite a 4 per cent increase in the Gross National Product (GNP) in 1994, a higher economic growth rate has had only a marginal impact on the centrally-planned sector of Polish farming (APA, 1994: 3).

2.5.4 Fiscal Policy (see section 7.2.3)

It has been shown that the major determinant of farm income is farm structure (Bowler, 1983; and Pacione, 1984) and both efficiency and income can only be improved by restructuring the farms themselves. Therefore, structural reform is viewed as the single long-term solution to low agricultural incomes. Structural change[100] in the rural environment is an essential prerequisite for the successful implementation of the market system, and more importantly, socio-economic improvement in the Polish agrarian community. Since 1989, international and European organisations[101] have helped the Polish government establish a number of associations and funds[102]

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[99]For instance the long cycle of production, longer time of return of capital and high capital-intensity (APA, 1994; further analysis in 6.5 and 7.2.3).

[100]A large number of schemes, under the umbrella of structural reform, have already been introduced in Europe, Canada and Australia. Countries with land consolidation legislation can be divided into three groups: (i) Northwest Europe, including Finland, Sweden, Norway, France, Denmark, Switzerland, (former) West Germany and the United Kingdom; (ii) Southern Europe or Mediterranean group, including Spain, Portugal, Italy, Greece and Cyprus and (iii) Developing countries, of which India, Taiwan and Kenya are most progressive (King and Burton, 1983. Land consolidation is the solution to farm fragmentation and involves the rearrangement of scattered parcels of land. Most countries have a consolidation authority, which determines the value of land and patterns of ownership and isolates areas of greatest need. Schemes can be compulsory, but voluntary and accelerated schemes are usually emphasised in an attempt to get farmers to actively participate in the process. The effect of voluntary schemes is inevitably slow and often enhanced by government intervention. Consequently, accelerated consolidation is usually preferred and occurs once a proportion of landowners (normally 70 per cent) in a designated area agrees to a consolidation plan. A major problem with the re-allocation of fragmented land is that it does not necessarily lead to an increase in farm-size or a reduction in the number of holdings. Usually, governments adopt a policy of farm enlargement to complement land consolidation.

Land reform is a radical attempt by certain governments to reorganise rural economies, for various social, economic and political reasons (Pacione, 1984). This usually takes the form of a redistribution of property in favour of landless peasants, tenants and small farms (King, 1977) and occurs throughout the world. Although such measures are useful in areas characterised by poverty, unemployment and exploitation, they have little overall effect on the structure of rural areas and are often not cost-effective because the peasants lack the necessary training and skill to cope with land-ownership and farm management (Ilbery, 1985).

[101]The 'Poland and Hungary Assistance for the Reconstruction of the Economy' (PHARE) programme was established in 1990 to support economic restructuring and democratic reform in Central and Eastern Europe. Its funding is used to channel technical, economic and infrastructural expertise and assistance to recipient states. The aim is to help these countries achieve market economies based on free enterprise and private industries. The European Community, on recognising the magnitude of the task, decided to complement G-24 bilateral aid with its own aid programme, and in December 1989, PHARE was launched as a specific aid programme. It dovetails, with the G-24 aid efforts, also co-ordinated by the European Commission and works closely with the World Bank, European Investment Bank, the European

for successful agricultural transformation. Such schemes involve the development of rural infrastructure; including roads and motorways, communications, electricity and gas supplies, irrigation and sanitation (Borek interview, 1994). Despite economic and social benefits to these projects (such as the absorption of surplus agricultural labour and improvement in the local rural economy), the IMF restricts the Polish government from making greater rural investment, in an attempt to control the government deficit (Borek, Butt and Banks interviews, 1994). Nevertheless, inadequacies of the rural infrastructure are cited as being one of the main obstacles to development and ones which are difficult to overcome by the farmers themselves (Braverman et al., 1993; and Szemberg interview, 1994).

Other such fundamental criteria are comprehensive agricultural training in modern farming techniques for farmers, together with financial and managerial education; research, technology and development (RDT); and an effective banking and financial system to promote both private investment and to attract foreign investment (Santorum and Borek interviews 1994). The government's role in improving the performance of the agricultural sector is to a large extent,

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Bank of Reconstruction and Development, and other states' assistance. There are currently 11 eligible countries: Albania, Bulgaria, the Federal Czech and Slovak Republics, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovenia (Commission of the European Communities, 1994). With respect to Poland, 90 per cent of the funds come under the central control of the Foundation of Assistance Programmes for Agriculture; a management unit, located in the Ministry of Agriculture, Warsaw. Between 1990 and 1995, PHARE financial commitments to Poland fell from 100 to 30 million European Currency Units. Their chief aims involved the supply of feed and plant protection and the assistance to rural agriculture (Kent interview, 1994; refer also to sections 6.5 and 7.4.3).

[102] (i) 'Agency for Agricultural Marketing' began operating in 1992. It provides assistance up and downstream of agriculture, promoting competition in the input and food processing industries.

(ii) ' ASAP' established in 1991, supports and monitors the World Bank loans (detailed in section 2.5).

(iii) 'European Development Fund' monitors European loans, specifically on a regional level, reaching the marginal areas.

(iv) 'American Programme' established since 1991, founded on an American-Polish Agreement with emphasis on increasing awareness and communication of price movements, via monthly magazines.

(v) 'Agricultural Extension Service Centres' located in each voivodship (county) were reorganised in 1990. They focus on improved seed and the newest technology, together with educating farmers at the voivodship and the farm level (via projects) and management and financial training. Yearly international exhibitions promote Western methodology (Borek and Hughes interview, 1994).

(vi) 'Agricultural Development Fund' (a spin-off from the British Know-How fund) was initiated in 1990 as a credit line for short-term loans to farmers. Its income exceeded 15 million US dollars.

(vii) 'Technical Assistance Fund', initiated in 1990, targeted both Marketing and the quality of agricultural produce (Borek and Hughes interviews, 1994).

(viii) 'Association for the Reconstruction and Modernisation of Agriculture' (ARMA) was initiated in March 1994 and is funded by the government budget (National Bank of Poland) and the World Bank. The total budget is $300 million; ARMA will receive $250 million between 1994-1999. It's overall aim is to 'Restructure and modernise agriculture, focusing on three levels of intervention: a) communal levels b) farmers schemes and c) small and medium enterprises. Subsidisation allows the association to offer cheaper credit rates than Polish national banks. Particular help is available to those farmers who wish to specialise in diary farming, to improve the quality of Polish milk (Borek and Santorum interviews, 1994).

limited. Between 1988-1993, the producer subsidy eqivalent in Poland declined from 24 to 16; reducing the incentive to produce (Tangermann, Josling and Munch, 1994). In 1991, only 4.5 per cent (=zl 13.6 trillion) of the government budget was assigned to agriculture and its affiliated industries (Anderson and Tangermann, 1991). In the 1993 budget, the respective value was 5.6 per cent (Wos interview, 1993); by 1994 it had fallen to 2.5 per cent but rose to 3 per cent in the 1996 budget (Reuter, December 1996). However, in real terms, it is likely to decline in the 1997 government budget (Reuter, December 1996). Any substantial reductions to agricultural budgets may prove detrimental in the long term, since agriculture contributes such a large percentage to Polish GDP with an equally high percentage of the labour force. One of the government's objectives is to increase the economic efficiency of the farms, by primarily enlarging existing farms via plot consolidation (ARMA offer cheap interest rates) or through the sale of (former) state property (for European comparisons, market farms range from 16-20-25 hectares) and/or product specialisation (Borek interview, 1994). Market forces will squeeze out the inefficient and uncompetitive private farms so that only 600,000 of the present 2.5 million private farms will remain by 2000 (Borek and Kwiecinski interviews, 1994). Older farmers are being encouraged out of farming with attractive retirement and pension packages funded by ARMA. The displaced labour are being encouraged into private sector activity and work associated indirectly with agriculture, such as handicrafts (documented in 7.5.3). Apart from a loose commitment to reduce the overall land devoted to agriculture by one million hectares by the year 2025, via the transfer of marginal lands to forestry and recreation (Wos interview, 1993; see also section 7.2.3 and Table VI.1, Appendix VI), one gets the impression that the government favours a more non-committal approach, allowing the forces of the invisible hand to direct economic progress. The underlying constraint and the reasoning behind such an approach is, quite frankly, the lack of available funds (Ash, 1992; Wos, Anuszewski and Borek interviews, 1993). However, over the next 10 or 20 years, agriculture will increasing dominate the political and economic forum (Banks interview, 1994).

2.6 Summary

Chapter 2 has reviewed the development of the Polish primary sector, embracing the political, economic and social aspects which have effected the organisation of Polish farming, as it exists today. The Polish farmer's 'resilience to change' during former communist rule resulted in a monopoly of private sector ownership, to the extent that only 18 per cent of all Polish territory ever fell under complete control of the state. The end result, of course, is a dual agricultural system, differing in structure, scale and size of operation, but producing the same product simultaneously. Thus, whilst Poland undergoes rapid economic reform, the response from the agricultural sector must be depicted from two initially, separate standpoints. The differentiation in ownership means 'Polish agriculture' per se has two distinct components. The short-term dictates dissimilar structural responses from each component so that the long-term objective of complete transition to a market-oriented economy is accomplished. Finally, Poland's economic growth rate reached 4 per cent in 1994, 7 per cent in 1995 and is forecast at 5.5 per cent in 1996, its inflation rate also declined to less than 30 per cent in 1995[103], making it one of the fastest growing countries within Europe (Wieczorek interview, 1994; Portugal, 1995; and East European Markets, June 1996). Yet, much of this success is a direct result of its entrepreneurial sector of small and medium sized enterprises (SMEs) which is proving to be the engine behind Poland's economic recovery (Wieczorek and Smith interviews, 1994; and Kasriel, 1995). This industrial dynamism is not as apparent within the rural areas:

> "..There is a problem determining prices. 1 kg cherries is valued at 2000 zlotys at the centre (agriculture extension services centre). The market price is valued at 5000 zl. This is very low income for farmers. The emphasis should be on changing mentality-becoming more decisive, intuitive and business-like. The profit incentive is non-existent. Farmers are complacent.." (Wosniak interview, 1993).

It is this very complacency which is hampering the future prosperity of Polish agriculture, above all else.

[103]And was forecast to fall to 19 per cent during 1996 (East European Markets, June 1996).

Chapter 3

The Theory of Production

3.1 Introduction

Production functions underpin economic theory. From the micro perspective, they generate production possibility frontiers, underlie the supply side of markets, suggest an explanation of income distribution and generate factor demand functions. At the macro-level, they lie behind aggregate supply.[104] forming the link between output and employment. In international trade, they are used to provide a rationale for the movement of goods, services and factors across national boundaries. They are also central to economic growth theory and to investigations into the rate of technical change (Beattie and Taylor, 1985; Heathfield and Wibe, 1987; and Kasliwal, 1995).

Chapter Three is in two parts. The first part (containing sections 3.2 and 3.3) documents the theoretical framework of production analysis, in general. Part II (comprising sections 3.4 to 3.7) focuses upon a specific neo-classical production model: the Cobb Douglas function. This part explores its theoretical context, its essential tests of isoquant convexity and an overview of the limitations often found with this particular production function is presented. Drawing largely upon earlier empirical studies[105] which have interfaced the Cobb Douglas model with farming production, this part verifies its alliance with Polish agriculture: the exact core of this thesis.

3.2 Theory of Production (further details are contained in Appendix IV)

Production is the process of combining and coordinating materials (inputs, factors, resources, or productive services) to create a good or a service (output or product). 'Input' and 'output' are only useful terms when they are related to a particular production process. Notably, an output from one production process may be either an intermediate good to another production cycle, or it may be a consumer good. For example, farm-grown vegetables could be regarded as 'output', yet they become an 'input' in the production cycle if fed to livestock. Nevertheless, a production function is a quantitative or mathematical description of the various technical production possibilities faced by a firm, industry or sector and gives the maximum output(s) in physical terms for each level of

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[104]The total of all goods and services produced in an economy, less exports, plus imports (Bannock, Baxter and Davies, 1987).

[105]Of industrialised, developing and transitional agriculture.

the inputs in physical terms. Mathematical specification of the production function can range from elementary algebraic functions, such as a quadratic function expressing wheat yield in relation to phosphate fertiliser applications, to a highly complex series of equations, such as a detailed model of wheat plant growth and response to phosphate fertilisation. The level of algebraic complexity of the production function hinges upon both the production process itself and the degree of accuracy desired. Likewise, variability of inputs, whether they are considered fixed or variable factors is a function of the time period. Whilst the long run is regarded as the time period in which all factors can be adjusted at a minimum cost, the short run is viewed as the time period in which 1 to (n-1) factors can be adjusted at zero costs (Beattie and Taylor, 1985; and Heathfield and Wibe, 1987).

There are several key assumptions which underpin production theory. First, the production process is monoperiodic. That is, a firm's production activity is organised in such a way that output generated in one time period is entirely separate or independent of production in the preceding or subsequent time periods. Thus, this assumption negates any dynamic characteristics of some production processes, such as pest control in one crop year that influences the insect population in the following year.[106] Second, all inputs and outputs are homogenous. There are no quality differences in a particular level of output or input. However, in empirical investigations, this assumption is often relaxed as heterogenous outputs and inputs are introduced by specifying a multidimensional production function that accounts for quality as well as quantity. Data manipulation, such as index numbers or weighted averages, may be offered as an alternative way of incorporating the qualitative dimension within a predominantly quantity based exercise (Beattie and Taylor, 1985 and Trueblood, 1989; detailed in Chapter 4 and an example of this is carried out in Chapters 5 and 6). Third, both the production function together with the product and factor price relationships are known with certainty.[107] In other words, the entrepreneur[108] has a clear

[106]Other examples include the 'cobweb' theorem (extensively discussed in 'Principles of Agricultural Economics. Markets and Prices in Less Developed Countries', Colman and Young, 1993).

[107]This assumes fully operational market forces and a transparent price mechanism to both producers and consumers. During the embryonic years of Polish economic transition, this may not necessary be the case. However, this Polish arable production model (1988-1993) was evolved around 'physical' levels of the output and inputs, and so agricultural market prices are indirectly incorporated within the production analysis (Chapters 4, 5 and 6 provide further documentation).

[108]It is acknowledged that entrepreneurial activity is a particular aspect of a capitalist economy. The central faction of the Polish farming community is the private farmer since he supplies over 80 per cent of agricultural supply to the market. Thus, within this context, the private Polish farmer is classified as an entrepreneur.

understanding of the exact input-output transformations and the product and factor price relationships.[109] Fourth, the acquisition of variable factors of production are not limited by any financial constraints. Finally, the goal of the firm is to maximise profit[110] or, in some cases, to minimise the cost of producing a specified level of output, subject to technical and economic forces and constraints (Beattie and Taylor, 1985).

There are four specific forces which directly influence the firms' or industry's decision on what to produce and the methods of production to employ. These forces include technical knowledge[111], product demand, factor supply and the firm's supply situation regarding capital funds. Technical knowledge translates as the information on all the possible combinations of the productive services and the associated output level. This knowledge is summarised in the production function. Product demand[112] and factor supply forces to the individual firm are represented by a continuous series of possible price-quantity combinations. However, one must remember that it is not the product price in the market (present or at time of sales) but the firms' expected price at the time of planning which determines the productive forces. With regards to the last force influencing production, it is assumed that a firm or enterprise, sector or industry is usually unrestrained in capital resources, and therefore is unrestricted in factor usage[113] (Beattie and Taylor, 1985; and Thomas, 1993).

3.3 The Neo-classical production function

The 'Neoclassical' production function is the most widely used production function because it is host to a variety of forms. In the traditional theory of the firm it expresses output, Q as a function of, typically two inputs: capital, K and labour, L

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[109]However, during early economic transformation, hyperinflation is likely to have distorted the product, input and factor price relationships (refer to section 5.2).

[110]Entrepreneurs may have different objectives, such as the maximisation of profit, sales or wealth; earning a specified percentage return on capital; minimising cost; maximising output for a given cost outlay or a utility function. Furthermore, one assumes that the behaviour of the economic agent is rational in choice or action (Beattie and Taylor, 1985).

[111]This is fixed in any given production function (detailed in section 6.2).

[112]Which is determined by the market position of the firm.

[113]However, this may not actually occur. The empirical investigation (in sections 5.4.2 and 7.3.1) has shown low levels of private capital investment was a result of lack of resources.

$$Q=Q(K, L) \qquad [3.1]$$

The variables Q, K, and L are flow variables so that [3.1] expresses a flow of output as a function of the flow of services provided by the two factor inputs.[114] Hence, K depicts the flow of services provided by the existing capital stock rather than the capital stock itself. Thus, K is determined by both the size of the capital stock and the extent of its utilisation. All the variables are assumed to be continuously variable and infinitely divisible. The production function is assumed to be such that the marginal products of capital, δQ/δK, and labour, δQ/δL, are both always positive but 'diminishing'. Thus, if capital inputs remain constant, the marginal productivity of labour will eventually decline. Similarly, if labour inputs remain constant, the marginal product of capital will fall (Heathfield and Wibe, 1985; and Thomas, 1993). K and L are assumed to be continuously substitutable which means there are an infinite number of feasible combinations of factor inputs (implying a broad variety of alternative techniques) which may be used to produce a given output. Such possible combinations trace out a constant-product curve or isoquant similar to those shown in Figure 3.1 below.

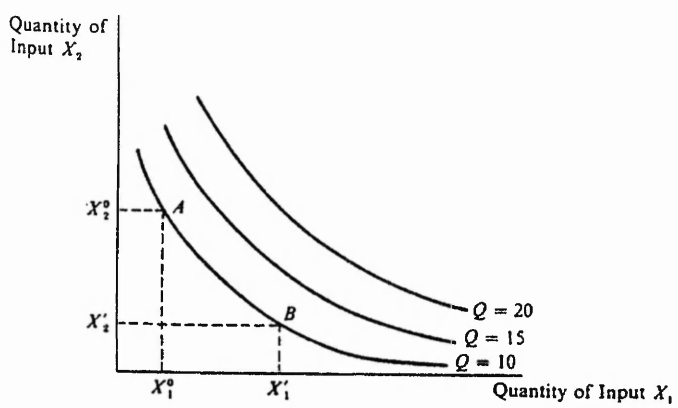

Figure 3.1: Convex isoquants

[114]Ambiguity often arises in the exact classification and measurement of 'flow' variables (refer to section 4.1).

The further from the origin the corresponding isoquant lies, the higher the given level of output. The slope of an isoquant measures the rate at which one input factor can be substituted for another, holding the level of output constant. The absolute value of this slope is known as the marginal rate of substitution (MRS)

$$\text{MRS} = -\frac{dK}{dL} \qquad [3.2]$$

Also, taking the total derivative of [3.1] gives:

$$dQ = \frac{\delta Q}{\delta K} dK + \frac{\delta Q}{\delta L} dL = 0 \qquad [3.3]$$

since output is assumed constant along the isoquant. Thus

$$\text{MRS} = -\frac{dK}{dL} = \frac{\delta Q}{\delta L} \div \frac{\delta Q}{\delta K} \qquad [3.4]$$

Therefore the MRS equals the ratio of the two marginal products. The MRS is assumed to decrease as more and more labour is substituted for capital. That is the greater the ratio of labour inputs to capital inputs the greater the quantity of labour needed to replace one unit of capital without reducing output. This means the isoquants are convex to the origin.[115] The more convex the isoquants, the more limited are substitution possibilities generally (see section 3.5 for convexity tests).

The MRS defines the degree of substitutability between factors in the production of a given output. However, it is measured in terms of units of capital divided by units of labour (for example, one machine per 15 man-hours) and hence its magnitude depends upon the units in which labour and capital are approximated. However, the elasticity of substitution is an alternative

[115]The shape of the isoquant may take on a variety of forms. First, negatively sloped and convex to the origin which is the case of imperfect factor substitutability (depicted in Figure 3.1). Second, the isoquants are straight lines and the production process is characterised by perfect factor substitutability. In this case, the isoquants may not be parallel but cannot intersect in the positive quadrant. Third, the isoquants are concave to the origin. Fourth and fifth, the isoquants are positively sloped and are convex to the x axis and the y axis respectively. Finally, when the inputs must always be combined in fixed proportions, there is no factor substitutability. In this case, the isoquants are right-angled to the origin. Economic analysis usually focuses on the first case. As for cases 3, 4 and 5, the same output can be produced with a lesser amount of at least one factor. Linear programming techniques are favoured for case 6 (Beattie and Taylor, 1985; refer to section 3.5 and Appendix VII).

way of summing up the substitution possibilities and is independent of the units of measurement chosen. It is expressed as:

$$\sigma=\frac{d(K/L)}{K/L}\div\frac{d(MRS)}{MRS} \qquad [3.5]$$

Therefore, it is the proportionate change in the ratio of capital and labour which occurs as we move along the isoquant, divided by the accompanying proportionate change in the MRS (the slope). Thus, if the isoquants are relatively flat (i.e. substitution is relatively easy), then movements along an isoquant (i.e. changes in the K/L ratio) are accompanied by little change in the MRS and hence the elasticity of substitution is high. However, if the isoquants have a pronounced curvature, implying the substitution possibilities are more limited, then σ will be low.

The combinations of factor inputs are usually defined within a model of firm behaviour where the firm maximises profits, π, where:

$$\Pi=pQ-mK-wL \qquad [3.6]$$

and p, m, and w are the prices of output, capital, and labour flows respectively. Assuming perfect competition in the product and factor markets, the firm is a price-taker and hence p, m, w may be treated as given. The firm maximises [3.6] subject to the constraints that inputs and outputs should satisfy the production function [3.1]. Forming the Lagrangean

$$H=pQ-mK-wL-\lambda[Q-Q(K,L)] \qquad [3.7]$$

the first-order conditions for a maximum are

$$\frac{\delta H}{\delta Q}=p-\lambda=0 \qquad [3.8]$$

$$\frac{\delta H}{\delta K}=-m+\lambda\frac{\delta Q}{\delta K}=0 \qquad [3.9]$$

$$\frac{\delta H}{\delta L}=-w+\lambda\frac{\delta Q}{\delta L}=0 \qquad [3.10]$$

From [3.8], if $p-\lambda=0$, $p=\lambda$. Thus eliminating the Lagrangean multiplier, λ, from [3.9] and [3.10] and re-arranging, we obtain the so-called marginal productivity conditions

$$\frac{\delta Q}{\delta K}=\frac{m}{p} \qquad [3.11]$$

and

$$\frac{\delta Q}{\delta L}=\frac{w}{p} \qquad [3.12]$$

Thus each factor is utilised up to the point where its marginal product equals its real price (in terms of output produced). Provided the required second-order conditions are satisfied, solving [3.11] and [3.12] together with [3.1] generates the profit maximising values of Q, K and L.

Within this context the production function must be viewed as merely one relationship in a three-equation system (comprised of [3.1], [3.11] and [3.12]) which jointly determines the values of the dependent variables, Q, K and L and in which the independent variables are m/p and w/p. Thus, given the above simple economic model, we see that the factor inputs, K and L, cannot be regarded as independent variables determining Q as the original single equation [3.1] might have superficially suggested.[116]

The following sections (3.4 to 3.7) focus specifically upon the Cobb Douglas model of production. Whilst they document the key assumptions underpinning its theoretical framework, they also consider its application within the agricultural economics literature. Using other empirical research, it validates the use of this model within the present study.

3.4 The Cobb-Douglas production function

The production function most commonly applied to aggregate data to distinguish between sources

[116]A dual economic model is one which output Q is assumed to be predetermined. The firm's aim is then to minimise costs subject to the constraint on its level of output Retaining the assumption that the firm is a price-taker, costs $C=mK+wL$ are therefore minimised subject to the output constraint $Q^0=Q(K,L)$ where Q^0 is the predetermined level of output. Forming the Lagrangean and working through yields another expression for σ, the elasticity of substitution in terms of w and m. Thus, $\sigma=d(K/L)/K/L \div d(w/m)/w/m$. This translates as the proportionate change in the capital/labour ratio divided by the proportionate change in the factor price ratio. When the price of labour rises relative to that of capital, firms will attempt to substitute capital for labour and increase the K/L ratio. When such substitution is possible only to a limited extent, a given proportionate change in w/m will lead to only small changes in K/L and the elasticity of substitution will be small. However, when considerable substitution is possible, σ will be large (Thomas, 1993).

of growth[117] empirically is the unrestricted form of the Cobb Douglas production function[118] (Gemma, 1989; and Thirwall, 1994; see also section 6.2). It may be written as

$$Q_t = TK^{\alpha}L^{\beta} \quad [3.13]$$

where T is an index of disembodied technology[119], 'total productivity' or an efficiency parameter, L and K are as previously defined, t denotes time, α is the production elasticity (responsiveness) of output with respect to capital (holding labour constant) and β is the production elasticity of output with respect to labour (holding capital constant) and can be interpreted as factor shares of the inputs (as shown from equations [3.16] and [3.17]). α and β are usually positive fractions, where β may or may not be equal to $(1-\alpha)$. Whilst the same principles and forces of production apply (as detailed in section 3.2), the additional features of this function include: homogeneity of degree $(\alpha+\beta)$ and in the special case of $\alpha+\beta=1$, it is linearly homogeneous[120] (Chiang, 1984; Gemma, 1989; Thomas, 1993; and Thirwall, 1994; refer to section 6.7).

The marginal products of capital and labour are given by

$$\frac{\delta Q_t}{\delta K_t} = \alpha TK_t^{\alpha-1}L_t^{\beta} = \alpha\frac{Q_t}{K_t} \quad [3.14]$$

and

$$\frac{\delta Q_t}{\delta L_t} = \beta TK_t^{\alpha}L_t^{\beta-1} = \beta\frac{Q_t}{L_t} \quad [3.15]$$

Assuming the firm is a price taker and a profit maximiser, equations [3.11] and [3.12] imply that the

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[117]Defined in 1.4.2.1.

[118]Originated by Wicksell in 1899, but popularised by Charles Cobb (a mathematician) and Paul Douglas (an economist), who pioneered research in the area of applied economic growth in the 1920s and 1930s. It originally arose from a study analysing the capital/labour relationship and Gross National Product (GNP) for US manufacturing industries in the early twentieth century. The difference between the log of capital and the log of GNP was always three times greater than the difference between the log of the labour force and the log of GNP. Although the function was derived from a study of the US manufacturing industry, it has been used copiously within other sectors of the economy (Cobb and Douglas, 1929; Beattie and Taylor, 1985 and Trueblood, 1989).

[119]As used by Boyd (1988, 1991).

[120]When $\alpha+\beta=1$, the production function is experiencing constant returns to scale: that is, if inputs are increased by x, output is increased by x. When $\alpha+\beta>1$, increasing returns to scale and when $\alpha+\beta<1$, decreasing returns to scale. For example, when $Q=TL^1K^1$, if inputs are doubled, output increases four times. When $Q=TL^{1/3}K^{1/3}$, if inputs increase eight times, output will only increase four times (Bannock, Baxter and Davies, 1987; refer to section 6.7).

marginal productivity conditions for this production function are:

$$\alpha \frac{Q_t}{K_t} = \frac{m}{p} \qquad [3.16]$$

$$\beta \frac{Q_t}{L_t} = \frac{w}{p} \qquad [3.17]$$

Cross multiplication rearranges equations [3.16] and [3.17] such that α=mK/pQ and β=wL/pQ. Thus, if the marginal productivity conditions hold, the exponents α and β in the Cobb Douglas production function are equal to the factor shares in the total output.[121] Note that for both models the optimising conditions imply that K/L= (α/β)/(w/m). Thus, for a given factor ratio, the greater is α/β the greater is the optimal capital/labour ratio. Thus the size of the exponent α, relative to that of β, determines the capital intensity of the productive processes represented by a Cobb-Douglas function.

3.5 Embodied Technical Progress

In 1956 and 1957, Abramovitz (1956) and Solow (1957) challenged the Cobb Douglas assumption that technical progress is independent of increases in factor inputs.[122] Their investigations of the US economy (1919-57) showed that between 80 and 90 per cent of growth of output per head could not be accounted for by increases in capital per head. As these results minimised the crucial role of capital accumulation and investment in the growth process, research proceeded on two fronts. First, methods to disaggregate the residual factor, measuring factor inputs in the conventional way. Second, attempts have been made to adjust the labour and capital input series for changes in the quality of factors. For example, the labour series has been adjusted

[121]In a cost minimising model with predetermined output, the cost-minimising condition is given by: MRS=(δQ/δL)/(δQ/δK)=βK/αL=w/m and this together with equation [3.13] yields the simultaneous system in the two independent variables K and L, with Q and w being in this case dependent (Thomas, 1993).

[122]However, certain endogenous models measuring technical progress have been developed making technology a function of the rate of growth of inputs. The arithmetic (such as the Laspeyres and Paasche indices) and the geometric growth accounting indices are such examples (Wong, 1986; Gemma, 1989; and Kasliwal, 1995).

for age, sex and education composition.[123] Similarly, the capital stock series has been adapted to allow for changes in composition and the fact that new additions to the capital stock in any line of production are likely to be more productive than the existing capital stock as a result of technical advance. Indeed, this is the notion of embodied technical change as opposed to disembodied technical progress, the original specification of the Cobb Douglas production function (Thomas, 1993; and Thirwall, 1994).

A distinction is now made between embodied and disembodied technical change-where the first refers to improvements that can only be introduced into the productive system by new investment and the second-exogeneous technical progress being independent of capital accumulation. There are several ways in which the embodied technical progress can be differentiated from the residual factor by appropriate adjustments to the capital series so that greater productivity is reflected by the latest investments. The net result is to enhance the role of capital accumulation in the growth process.

3.5.1 Embodied Technical Progress: Improvements In Capital

If capital is measured either net at constant prices, or as the physical number of capital inventories, and all ages and vintages of capital are treated alike, technical change associated with capital investment becomes part of the residual factor in the growth equation. The ultimate effect of adjusting the capital stock series for embodied technical progress is to raise the sensitivity of the growth rate to changes in the rate of capital accumulation. Experimenting with the embodied technical progress hypothesis is in fact a complicated technique because measures of the appropriate capital stock can only be properly corrected for the effect of technical progress if the rate of progress is known. As this is, generally speaking unknown, it is necessary to implement a system of trial and error. In general, applied studies fall into two categories: those that attempt to measure precise rates of embodied technical change and those that want to assess only its relative importance. As for the latter, one way is to measure capital gross at current prices, as oppossed to net and constant prices. If capital is measured in this way, technical change in capital is implicitly reflected in the price variable leaving disembodied change in the residual factor. Alternatively, an exponential time trend can be added to the traditional Cobb Douglas production function, representing a constant rate of productivity advance, and this may be called disembodied

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[123]As carried out in a study by Fleisher and Liu (1992); see also 5.5.4.

technical progress.[124] The difficulty here is that embodied technical change may also grow exponentially if the growth of the capital stock is fairly constant (Thirwall, 1978).

A more precise evaluation of the rate of embodied technical change is the so-called vintage approach to the measurement of capital. This approach was developed and applied to the traditional form of the Cobb Douglas production function by Professor Solow. In essence, the model consists of giving a separate valuation to each year's addition to the capital stock, with a higher weight being assigned to the most recent and presumably the most productive additions. The problem lies in deciding the weights.

Solow's original model (1960) has estimation problems, but Nelson (1964) has produced a similar model, where the 'effective' capital stock is a function of gross capital stock, its average age, and the rate of productivity improvement of new capital goods. Denoting the 'effective' capital stock as τ, the Cobb Douglas function as modified for changes in the quality of capital may be written as:

$$Q_t = T_t \tau_t^{\alpha} L_t^{\beta} \qquad [3.18]$$

where τ is the quality-weighted sum of capital goods, T is now an index of total productivity excluding the effect of technical progress embodied in new capital and L is labour. Assuming that technical progress improves the quality of new machines at a constant rate per annum (λ_K), then:

$$\tau_t = \sum_{0}^{t} K_{vt} (1+\lambda_k)^{v} \qquad [3.19]$$

where K_{vt} is the amount of capital built in year V (of vintage year) which is still in use on time $_t$. K_{vt} is gross capital of vintage, V, and the variable,$_t\tau$ is thus an integral value of capital with different vintages.

A change in the rate of growth of capital will alter the age distribution of capital, affecting the productivity of capital in that the gap between the average technology and the best-practice techniques will be changing. A decrease in the average age of capital will improve the productivity

$$-\lambda_K \Delta\bar{A} \qquad [3.20]$$

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124 See for example, studies by Brooks (1983), Wong (1986), Florkowski, Hill and Zareba (1988), Fan (1991), Yao (1993) and Johnson et al. (1994).

of capital by an amount equal to:

where $\Delta\bar{A}$ is the change in the average age of capital ($\Delta\bar{A}$ is negative if the capital stock is getting younger owing to a faster accumulation of capital).

The rate of growth of the 'effective' capital stock may therefore be written as:

$$\frac{\Delta\tau}{\tau}=\frac{\Delta K}{K}+\lambda_K-\lambda_K\Delta\bar{A} \qquad [3.21]$$

where $\Delta K/K$ is the rate of growth of the actual capital stock, λ_K is the rate of growth of improvement in the capital stock, and $\lambda_K\Delta\bar{A}$ is the effect of changes in the average age of the capital stock, which is a function of the investment ratio.

Using the existing capital data set and ascribing an estimate to λ_K (technical progress improves the quality of new machines by a constant rate per annum), it is possible to derive a new index for the capital variable. However, the question remains as how to measure λK in the vintage approach. The only conceivable method is to experiment with different rates of embodied technical progress and, on a trial and error basis, choose the rate which gives the best statistical fit when the function is estimated using empirical data for the other variables. Needless to say, the technique is arbitrary, but given values of λ_K and $\lambda_K\Delta\bar{A}$, the sensitivity of output with respect to capital is raised. Improvements to capital can be regarded as equivalent to physical increases in the quantity of capital of a few extra per cent and the contribution of capital is enhanced.

Empirical investigations of the significance of the embodiment hypothesis, however, have illustrated some conflicting arguments. For example, in Nelson's (1964) study of the US economy (1900-50), almost all of the variation in growth of labour productivity was associated with variations in the average age of the capital stock, as oppossed to variations in λ_K, even if full embodiment is assumed. These results suggest the ratio of investment to total output of a country is crucial to growth, as the average age of capital is inversely related to the rate of investment. However, Denison (1964) has argued that the embodiment effect functions exclusively through the age distribution of capital and, as this is subject to very small variation, it must be insignificant in practice. However, changes in the average age of capital stock are not the only distinction between embodied and disembodied progress. The average age of capital may remain the same, but at the same time more productive machines may be replacing those that are wearing out. Several US-based studies which have attempted to estimate embodied technical progress by the trial-and-error procedure mentioned, arrived at annual improvement rates of between 2 and 5 per cent (Thirwall, 1994).

Studies of advanced industrialised countries have tended to confirm the relative unimportance of capital compared with other growth-inducing variables (Denison, 1967). In fact, capital growth has rarely accounted for more than 50 per cent of the measured growth of output despite allowing for changes in the composition of capital and embodiment (Thirwall, 1994). For example, Solow (1962), using an embodied model, finds the weighted contribution of embodied technical progress for plant and machinery less than that of disembodied progress.

In contrast, production-based studies of less developed countries (LDCs) have found capital accumulation is a much more important source of growth in LDCs than it appears to be in industrialised countries (Maddison, 1970; and Nadiri, 1972). Robinson's cross-sectional study (1971) based on data from 39 countries during 1958-66 distinguishes four major sources of growth together with a residual: the contribution of labour; the contribution of capital; the effect of resources transfers from agriculture; and the effect of foreign borrowing. Two alternative specifications were used in his model. Whereas the variable measuring foreign borrowing was restricted to zero in the former equation, in the latter there were no restrictions placed on any of the explanatory variables. Table 3.1 below presents the results of his study.

Table 3.1: Results of Robinson's study (1971)

	Contributions to growth (%)				
Variables	Labour	Capital	Foreign Borrowing	Residual	Resource Shifts
Equation 1	20	52	\	12	16
Equation 2	19	32	14	18	17

[Source: Thirwall, 1994]

As represented in Table 3.1, the results indicate foreign borrowing is an identifiable source of economic growth. However, when it is introduced into the relationship, the contribution of capital to economic growth falls by 20 per cent. In other words, the research suggest foreign borrowing is in fact a scarce factor specifically restricting capital accumulation and in turn economic growth. Indeed, other studies by Hagen and Hawrylyshyn (1969) and the World Bank (1991) complement Robinson's findings.

Despite the range of studies devoted to the identification of sources of economic growth, the overall conclusions relating to investigations of LDCs are relatively consistent. In general, the results suggest the major sources of growth in LDCs have been growth in the factors themselves, aided by improvements in the quality of labour through health and education. The total factor productivity growth is also shown to be of less importance in LDCs than in industrialised countries, but that capital accumulation is a significant contributor to growth (Hagen and Hawrylyshyln, 1969; Nadiri, 1972; Maddison, 1970; and World Bank, 1991).

3.5.2 Empirical Implications of the Embodied Technical Progress Hypothesis

Based upon findings of earlier studies using the embodied technical progress hypothesis (3.5.1), it is possible to make some suppositions surrounding the empirical component of this thesis. If an embodied technical progress model had been developed, it is likely that the aggregate elasticity estimates generated by the operative capital (α) and fertiliser (ζ) variables would have been markedly different. The subsequent analysis considers the implications of using an embodied technical progress hypothesis.

It is hypothesised that technical growth improved the quality of both operative capital and fertiliser application during 1987-93. Owing to no available data on the age and price distributions of Polish tractors and fertilisers respectively, it is impossible to use either the vintage approach[125] or constant prices to quality-adjust both the operative capital and the fertiliser application indices. Nevertheless, some inferences may still be made. First, an embodied estimate of the national[126] private aggregate operative capital elasticity coefficient, named α', is likely to be larger than its equivalent empirically derived estimate, α^p.[127] Based upon general findings[128], α' could be inflated upwards by between 2 and 5 per cent.[129] This is because not only did the rate of private operative capital investment rise during 1987-93[130], but technical growth would have further intensified the

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[125]Detailed in 3.5.1.

[126]This means data referring to all 49 voivodships (counties) were used in the regression (see Chapter 6).

[127]α^p=0.172 (see 6.6 and 7.3).

[128]As outlined in 3.5.1.

[129]Op cit.

[130]See 5.5.3.1.

role of operative capital in the production process.

In contrast, the (former) state sector experienced national capital divestment as the number of operative tractors continued on a downward trend.[131] It is therefore hypothesised that (former) socialised farming suffered a decline in capital formation as well as failing to appreciate any advances made in technology. It follows that an embodied estimate of the national aggregate (former) state operative capital elasticity coefficient, named α'', is feasibly lower than its empirical value, α^s.[132]

With regards to fertiliser usage, it is likely that any technological advancements made during early economic transition would have been eroded by hyperinflation.[133] As a consequence, the demand for agricultural inputs fell in both farming sectors. Therefore, it is assumed that an embodied approximation of the fertiliser elasticity estimated (ζ) would have been similar in magnitude to those derived in the empirical investigation using the disembodied technical progress hypothesis.

The rate of technological change itself, however, may have been spatially distinctive during early economic transformation. Indeed, there is already a substantial body of research[134] which advocates regional diversification in Polish agricultural production. Such differences include ownership, land use, farm size, agricultural practices, rates of investment and capital intensity.[135] As farming in the north western region of Poland is the leading quarter, the pace of technical progress may have been faster than in the remaining regions. An embodied aggregate operative capital elasticity parameter generated by north western farming is likely to be higher than its existing disembodied estimate.[136]

Finally, regardless of the alterations made to the capital variable to account for embodied technical progress, overall changes in development would have come about through increases in the factor resources themselves anyway.

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[131]See 5.5.3.1.

[132]α^s=0.420 (See 6.6 and 7.3).

[133]Detailed in 1.1 and 2.5.

[134]For example, Dawson, 1982; Boyd, 1988, 1991; Szemberg, 1992a; Szemberg, 1992b; Szemberg, 1992c; Szemberg, 1992d; and Szemberg, 1994.

[135]See 5.4.

[136]α=0.141 (see Table 6.6).

3.6 Tests for convexity

As previously outlined (section 3.3), the isoquants of a Cobb Douglas production function are strictly convex to the origin and downward sloping. In the main, strict convexity can be verified from the signs of the derivatives dK/dL and d^2L/dK^2 (or dL/dK and d^2K/dL^2). For any positive output, Q_o, [3.13] can be expressed as:

$$TK^{\alpha}L^{\beta}=Q_0 \qquad [3.22]$$

and (T, K, L, Q_0>0 and α and β are positive fractions)
Taking natural log of both sides and transposing, we find that

$$\ln T+\alpha\ln K+\beta\ln L-\ln Q_0=0 \qquad [3.23]$$

which implicitly defines K as a function of L. By the implicit function rule[137] and the log rule, therefore, we have

$$\frac{dK}{dL}=-\frac{\delta F/\delta L}{\delta F/\delta K}=-\frac{\beta(\frac{1}{L})}{\alpha(\frac{1}{K})}=-\frac{(\beta/L)}{(\alpha/K)}=-\frac{\beta K}{\alpha L}<0 \qquad [3.24]$$

Then it follows that[138]

$$\frac{d^2K}{dL^2}=\frac{d}{dL}(-\frac{\beta K}{\alpha L})=-\frac{\beta}{\alpha}\frac{d}{dL}(\frac{K}{L})=-\frac{\beta}{\alpha}\frac{1}{L^2}(L\frac{dK}{dL}-K)>0 \qquad [3.25]$$

If dK/dL is less than zero, as derived in equation [3.20], then d^2K/dL^2 must be positive. The signs of these derivatives establish the isoquant (any isoquant) to be downward-sloping throughout and strictly convex in the LK plane for positive values of L and K.

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[137]In general, the implicit function rule can be described as: $F(y, x_1..., x_m)=0$, if an implicit function $y=f(x_1..x_m)$ exists, then the partial derivatives of f are: $\delta y/\delta x_i = -Fi/F_y$. (i=1,2,..m). In the simple case when the given equation is F(y,x)=0, the rule gives $dy/dx=-F_x/F_y$. Thus for the equation F(Q,L,K)=0, the marginal products are the partial derivatives, i.e. δQ/δK, δQ/δL and δK/δL, we can apply the implicit function rule and write $MPP_K=\delta Q/\delta K= -F_K/F_Q$, $MPP_L=\delta Q/\delta L= -F_L/F_Q$ and $\delta K/\delta L =-F_L/F_K$ (Chiang, 1984).

[138]Using the quotient rule of differentiation.

3.6.1 Empirical Application

It transpires that at the present time, there is no prescribed 'test of convexity' within existing computer or statistical applications. Based upon this fact, an arbitrary test using raw data was devised to determine the gradients (positive or negative) of the isoquants of the arable production functions generated by the Polish private and (former) socialised agricultural sectors[139] and presented in this thesis.[140] Limiting the analysis to three 'conventional'[141] explanatory variables[142], namely, output, capital and labour[143], three (approximate) categories of aggregate arable output were selected from the secondary agricultural data (1993) gathered on all 49 Polish voivodships (counties).[144] The categories ranged between 400-800 thousand arable tonnes; 1600-1900 thousand arable tonnes and 2100-2500 thousand arable tonnes for the private sector; and between 10-20 thousand arable tonnes; 80-200 thousand arable tonnes and 200-350 thousand arable tonnes for the (former) state sector. Three-dimensional graphs were used to illustrate the alternative combinations of arable output against its corresponding ratio of 'conventional' inputs, namely the flow of 'capital' and 'labour' inventories. At the cross-section of the labour and capital planes, the isoquants were convex to the origin and negatively sloping. In fact, the results were consistent for all three categories of arable production and in both the private and (former) state sectors. The post-regression analysis used the empirical values of α and β coefficients generated from the arable production models (in Chapter 6) to confirm strict convexity (as described above; further details are contained in Appendix VII).

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[139]Section 5.4.1 provides the definitions of both 'private' and (former) 'state' farming adopted in this thesis.

[140]A test of convexity is particularly relevant to the present investigation of Polish agricultural production. This is primarily because of characteristics associated with economic transition. These include imperfect information and perhaps unreliable price signals. Consequently, factor usage may have been perverse and the allocation of resources uneconomical. For example, a higher cost factor (capital) may have been substituted for a lower cost factor (labour) (refer to Appendix VII).

[141]Documented in section 4.4.

[142]It is acknowledged that this particular test may be elaborated to include some of the other exogenous variables, such as fertilisers or land, which are included within this Cobb Douglas model of arable production.

[143]Sections 5.5.1, 5.5.3 and 5.5.4 provide the respective definitions of 'output', 'capital' and 'labour' used in this thesis.

[144]Detailed in sections 1.3, 4.2.1 and 5.4.2.

3.7 Restrictions of the Cobb Douglas production function

The Cobb Douglas model has a number of limitations arising from its original assumptions. It is important to emphasise these restrictions, particularly within the context of development theory and in the accurate identification of the sources of economic growth. This is an especially meaningful point when analysing growth in developing, advanced or transitional economies. For example, in the case of constant elasticity of substitution, the sum of α and β is assumed to be always equal to unity and the values of α and β are assigned a priori according to the share of capital and labour in the national income. This is based upon the assumption of a perfectly competitive market where production is subject to constant returns, factors are paid their marginal product and factor shares reflect the elasticity of output with respect to each factor. However, in both developing and transitional economies, the assumption of a perfect competitive market is a rather tenuous one and thus, the elasticity of substitution is not always necessarily equal to unity[145] (Thirwall, 1994; refer to section 6.7).

Furthermore, the function of constant elasticity means that the function cannot represent a change in the ease of substitution between capital and labour. If the elasticity of substitution differs greatly from unity and there are widely different growth rates of factors, over or underestimation of the contribution of capital and/or labour inputs to economic growth may occur. For example, if the elasticity of substitution between capital and labour is significantly less than unity and capital grows faster than labour, this will lead to an overestimation of capital and an underestimation of other factors. On the other hand, if the elasticity of substitution is assumed to be higher than it is, the role of the fastest growing factor is exaggerated. If both capital and labour expand at the same rate, growth is independent of the elasticity of substitution (Thirwall, 1994).

The use of the Cobb Douglas model of production has been criticised on a number of other conceptual issues. First, since only one combination of factor inputs can be observed at any one time, there is an identification problem in attempting to distinguish shifts in production (technological progress) from movements along the function (changes in factor intensity) unless the assumption of neutral technical progress is made. But, technical progress may not be neutral

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[145]Problems associated with this particular assumption gave rise to an improvement in the form of the production function. Developed by Solow, Minhas, Arrow and Chenery (SMAC) in 1961, their production model is known as the 'constant elasticity of substitution function' (CES). In contrast, whereas the elasticity of substitution is defined as a constant, it could adopt alternative values apart from unity (Thomas, 1993).

and therefore changing factor intensity becomes confused, biasing the results of the contribution of factor inputs and technical progress to growth.[146] Second, the formation of an aggregate or macro production function, based upon micro-production functions creates further discrepancies. If, for example, a Cobb Douglas production function was derived across firms or industries, this implies the aggregation of output, capital and labour flows. It is likely that widely different types of output are produced from varying productive techniques. Thus, it is naive to assume that the magnitude of α and β could be the same across industries. In addition, the capital and labour intensities are likely to differ from industry to industry. This would not matter so much if capital and labour expanded at the same pace, but generally speaking industries expand at different rates. Thus, the expansion in the level of aggregate output will also depend upon the way in which the increased inputs are distributed across industries. Thus, whilst in a characteristically labour-intensive industry additional labour inputs would boost aggregate output, in a capital-intensive environment, increases in capital would boost aggregate output. Furthermore, the flow of new factors to the industries is ultimately related to factor prices which are likely to differ from industry to industry as influenced by non-competitive conditions. Thus, it is impossible to cite a purely physical relationship in terms of aggregate output and inputs without some impact from factor prices.[147] Thus, although the simplicity of creating a single production function to explain the relationship between inputs, output and current technology is an attractive one in theory, its accuracy and reliability is rather ambiguous in practice (Thomas, 1993).

A final criticism relates to the measurement of outputs (products) and inputs (factors). The evaluation of the factor-product relationship of a firm, industry or sector will invariably result in the aggregation of heterogenous quantities. Thus, additional variables (such as 'education' for labour inputs), index numbers or weighted averages are often used to either qualify the data or to compensate for the inequality in factor inputs (see for example, Hayami and Ruttan, 1971; and Boyd, 1988, 1991). Analysis of empirical investigations reveal both a great variety of techniques used but that the manipulation processes are related extensively to both the accessibility and the availability of farming data (Chapters 4, 5 and 6 elaborate on this theme).

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[146]This issue also relates to the type of data used in the analysis. Whilst time series data detects shifts in production, cross-sectional data encapsulates changes in factor intensity (detailed in section 4.2).

[147]On the assumption that there is complete information available on factor prices and that they are consistent with input and product price coefficients (documented in section 4.4.1).

Despite the inherent theoretical problems associated with the Cobb Douglas production function, in practice, its empirical application tends to eliminate these potential drawbacks. First, numerous studies of technical change on advanced economies have shown that the assumption of neutrality is a fairly relevant hypothesis. Second, growth rates in capital and labour would have to differ substantially to effect the elasticity of substitution, and in any case, the majority of studies have shown that it is close to unity. Third, a number of techniques have been developed to combat concerns over the measurement of so-called 'homogenous' quantities. Finally, a succinct statistical description of the relationship between capital, labour and output has meant the attractiveness of production function analysis has not waned (Thomas, 1993; Thirwall, 1994; Battese, Malik and Gill, 1996; Bhattacharvya and Bhattacharvya, 1996; and Sharif and Dar,, 1996; further documentation in Chapter 4).

3.8 The Cobb Douglas production function and its application to agriculture

Production function analysis has been applied to agriculture since the early 1950s. Whilst Bhatterjee developed a single production function to express global farming output ('metaproduction function') in 1955, other economists have focused on specific regions, areas or countries. Broadly speaking, production functions may be classified into three categories: the inter-country, national and regional. The inter-country studies usually combine data from a representative sample of less developed countries (LDCs) and industrialised countries[148], or alternatively they may focus entirely on a particular type of economy. For example, empirical work on the agricultural sectors of socialist countries include those by Clayton (1980), Wong and Ruttan (1983), Wong (1986), and Brooks (1983, 1991). Agricultural production studies of transitional economies include those by Fleisher and Liu (1992), Lin (1989), Lai (1991), Brock (1994), and Johnson et al. (1994). Whilst, examples of regional and country-specific studies are illustrated by the work by Yotopoulos (1968), Ghosh (1971), Kazmi (1971), Rao and Chotigeat (1981), Yao (1993), Battese, Malik and Gill (1996), and Bhattacharvya and Bhattacharvya (1996); Florkowski, Hill and Zareba (1988) and Boyd (1988, 1991) focused on agricultural production in Poland (Chapters 4 and 7 elaborate on the methodological context of earlier studies and Chapters 5 and 6 focus on the variable specifications of this study).

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[148]Bhattacharjee, 1955; Hayami and Ruttan, 1971, 1985; Evenson and Kislev, 1975; Nguyen, 1979; Yamada and Ruttan, 1980; Antle, 1983; Cornia, 1984; Kawogoe, Hayami and Ruttan, 1985; and Lau and Yotopoulos, 1968.

The actual derivation of the metaproduction or national production functions are not limited by any specific functional form. For example, they can adopt the constant elasticity of substitution (CES)[149], the Cobb Douglas[150], the Linear Elasticity of substitution[151] or the translog (TL) function[152] (Trueblood, 1989). Despite the variety of functional forms, according to Wong (1986: 31), the Cobb Douglas is 'one of the most widely used production function and is especially popular for aggregate data.' Due to its popularity, international comparisons with other studies may be made and sources of growth identified across developing, industrialised, socialist or transitional countries or regions. Moreover, its structural form means that it can be extended to include any number of additional independent variables.[153]

The criteria involved in deciding which model to adopt in any empirical investigation is influenced by the nature of the data (Ghosh, 1971; and Florkowski, Hill and Zareba, 1988), the ease of manipulation and the interpretation of results (Ghosh, 1971; and Kawagoe, Hayami and Ruttan, 1985). Another reason cited is that it avoids multicollinearity, a problem inherent in the TL function (Kawagoe, Hayami and Ruttan, 1985). Occasionally the organisation of agricultural production within a particular boundary or country is an additional factor which determines the choice of functional form (Clayton, 1980). However, authors often use various functional forms of similar models and compare results for significant differences (Ghosh, 1971). For example, Fleisher and Liu, (1992) used Cobb Douglas because of 'its simplicity, apparent good fit to Chinese data and its suitability with real measures of inputs.' (Fleisher and Liu, 1992: 113). However, they stated that 'we used the Cobb Douglas only as a useful approximation' (Fleisher and Liu, 1992: 119); nevertheless alternative specifications did not derive significantly different

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[149]Defined in section 3.4.

[150]In summary, Cobb Douglas is when the MRS=1 and the isoquants are downward sloping and convex to the origin.

[151]In summary, linear function is when the MRS is a negative constant, and the isoquants are negatively sloped but linear. The function does not depend on the combination of the inputs considered and the elasticity of substitution is infinite.

[152]The transcendental or translog is when the MRS lies between zero and infinity and depends on the combination of inputs involved (Kawogoe, Hayami and Ruttan, 1985; and Hatziprokopiou and Karagiannis, 1996).

[153]The variables usually chosen as the possible sources of productivity change over time divide into three broad categories. These categories can then be subdivided further: (i) resource endowments; (ii) technical inputs and (iii) human capital. Resource endowments include labour, land and internal capital accumulation. Technical inputs include machinery and chemical devices, and biological and chemical materials purchased from the industrial sector. Human capital generally includes education, skill, knowledge and capacity embodied in the population of the agricultural sector (Trueblood, 1989).

empirical results (Boyd, 1991; Fleisher and Liu, 1992; and Yao, 1993).

Boyd (1988, 1991) justifies his use of the Cobb Douglas production function because it complemented his study objectives. Despite its restrictive assumptions, the model permits a useful specification of policy, environment, and system effects through its disembodied technical change component. He also wanted robust estimates which could be readily interpreted. The Cobb Douglas estimates were significant under a wide variety of combinations of constraints, and the interpretation of the intercept and time trends as regional and policy proxies was straightforward. He tried other functional forms such as the TL function but found the data did not produce useful point estimates (Boyd, 1988, 1991).

Brock (1994) used the transcendental log function in his study of Former Soviet Union (FSU) farming because it was more suitable for testing factor substitution than the Cobb Douglas which is more appropriate in determining the output elasticities and sources of growth (Brock, 1994). Likewise, Rao and Chotigeat (1981) chose the translog/transcendental function for their study of Indian farming, because, unlike the Cobb Douglas function, it is not locally constrained by assumptions of homogeneity or additivity. In addition, their pooled data set may have given rise to serial correlation in the error term (different regions, size of land holdings, different time periods).[154] Finally, their choice in a particular set of regressors was based upon intuitive considerations and data availability (Rao and Chotigeat, 1981). In Yao's (1993) study of Ethiopian farming, the results from the classical Cobb Douglas model were used in the final analysis after many experiments with the CES and the TL functions, but with no better results (Yao, 1993).

Criticisms of the Cobb Douglas production function include those from Doll (1974) who attacks the model on a number of counts. First for the presence of multicollinearity and the associated impact of multicollinearity. Second, for input aggregation, third for the specification error and finally, for the exclusion of management. In fact, endless objections of its basic assumptions or functional form over the years has substantially changed the production function approach. As a result, stochastic frontier analysis and the Bayesian technique[155] have been developed.

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[154]Serial autocorrelation occurred during Stage I of development of this arable production model (detailed in section 6.3).

[155]The bayesian approach uses a priori information and its authors include Chowdhury, Nagadevara and Heady (1975); and Zellner and Richard (1973).

The stochastic frontier analysis to estimate technical efficiency was pioneered by Farrell (1957). Other studies include Zellner, Kmenta and Dreze (1966); Wu (1975); Aigner et al. (1977); Meeusen and van der Broeck (1977); Johnson et al. (1994) and Bhattacharvya and Bhattacharvya (1996). The essential idea behind the stochastic frontier approach is that the production function is viewed as a locus of maximum output levels from a given input set and thus the output of each firm is bounded above by a frontier. The frontier is assumed to be stochastic, because profits may be stochastic, in order to capture exogenous shocks beyond the control of the firms. Since all firms are not able to produce the frontier output, an additional one sided error is introduced to a variety of industries (Kumbhakar, 1987). As for its empirical applications, Johnson et al. (1994) recently used this technique in their study of agricultural output in the Ukraine, and Sharif and Dar (1996), in their study of technical inefficiency of rice cultivation in Bangaldeshi farming.

3.9 Summary

Chapter 3 has focused on the theoretical underpinnings of the Cobb Douglas production function and its application to farming. Overwhelming evidence from earlier empirical work suggests this particular model of production has been applied to farming across varying degrees of spatial analysis in order to identify sources of economic growth, factor substitution and output elasticities. The distinction has been drawn between disembodied and embodied technical progress. Whilst it still remains one of the most popular tools for micro, macro and development economists, the assumptions to the model have been criticised on economic grounds as well as from other fields of research. Nevertheless, the crux of any investigation of production lies in the limitation and control of distortions, so that, at least, some interpretations of the efficiency of agriculture can be made. Although functions, in their general format can be derived, ultimately, the nature of the data available defines the scope and progression of any study. In conclusion, the application of the Cobb-Douglas production function to this present study of Polish farming has been chosen because of its simplicity in application and suitability with aggregate national agricultural data. Furthermore, because of its integral relationship with the study objectives, it aids estimation of the output elasticities of Polish farming during the embryonic years of economic transition.

Chapter 4

Model specification of the Cobb Douglas agricultural production function

4.1 Introduction

The production process involves services from a combination of resources which may be classified as either stock or flow services. The categorisation and measurement of resources as stock or flow services is ambiguous, and depends partly on the length of time under consideration. Some resources embody stock services (fertilisers, feed, tractor fuel) and may be used up entirely in the production process, or may be stored for a later time period. Other resources represent flow services (machinery, buildings, labour, certain soil elements) and if the services are not used when they are given off from the resource they will not be attainable in a subsequent time period.[156] However, some factors of production embody both flow and stock services. This situation is certainly true for machinery as depreciation is a function of both use and time, but may be extended to include both land and buildings. From a purely spatial viewpoint, land services are of a flow nature. Soil nitrogen, however, may represent a stock of services; if used up in one time period it will not be available in a later period. Buildings too include both stock and flow services. For example, a building which lasts 50 years provides a flow of services in each of the individual years; but a stock of services for a 50-year period (Heady, 1961). In agricultural production analyses, authors have defined and estimated the resources used in the processes of agricultural production. Suffice it to say, some discrepancies have arisen.

Chapter Four documents the various ways in which both the 'output' (product) and the 'inputs' (factors) can be measured in models of farming production. Drawing largely upon earlier empirical fieldwork at three alternative spatial levels (international, national and regional), it describes the separate procedures which have been developed to quantify the dependent and independent variables. The subsequent analysis is in two broad components: the first (containing sections 4.2 and 4.3) focuses specifically on earlier Polish agricultural production studies; the second provides an overview of the non-Polish agricultural production functions (sections 4.4 and 4.5). Both components subdivide into five subsections: Output, Land, Capital, Labour and Nonconventional variables.

[156] If the energy of a labourer is not used today it cannot be stored until next year. On the other hand, if the flow services of one period are used, the flow of another period will still be forthcoming (Heady, 1961).

4.2 The Polish Context

4.2.1 Introduction

This section is devoted specifically to two previous Cobb Douglas studies of Polish agricultural production. The authors selected the statistical information from a number of sources at the Central Statistical Office (GUS) in Warsaw, Poland. Boyd (1988, 1991) focused his work on the contrast between the socialised and the privatised farms in Eastern Europe, in an attempt to measure the effects of policy and bureaucratic allocation on agricultural productivity. He used the disembodied technical progress hypothesis, the original specification of the Cobb Douglas production function (see 3.4 and 3.5). He collected panel data on six variables: output, land, labour, livestock, machinery and fertiliser across the voivodships[157] (counties) of Poland during the years 1960-1982. He also used three additional dummies: for ownership (private and socialised); region (southwest, southeast, northeast and northwest)[158]; and temporal (1960-1969, 1970-1974, 1975-1979, 1980-1982). Whilst Ordinary Least Squares (OLS) has been the most accepted estimation method, Boyd (1988, 1991) used the Instrumental Variables (IV)[159] technique where the instruments were the one-year lagged values of the independent variables plus all regional, temporal and sectoral dummy variables. He used a distributed lagged model for estimation as the effect of a unit change in the independent variable may have been distributed over a number of time periods. Psychological (inertia), technological and institutional reasons are often used to explain time delays in response (see Gujarati, 1992: 411).

Florkowski, Hill and Zareba (1988) gathered cross-sectional annual data (1955-1983) and analysed the impacts of government policy on food production in the Polish state, co-operative and private sectors. The authors estimated two separate production functions for arable and

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[157]Defined in section 1.3.

[158]Before 1974 there were seventeen voivodships (counties) but after 1975, they were segregated further into 49 voivodships (counties). Based upon materials in Kostrowicki et al. (1978) and estimation of various combinations, Boyd (1988) divided the country into four separate regions (Boyd, 1988). Using the 1960-1974 political divisions, these regions were as follows: southeast-Bialstok, Warszawa, and Olsztyn; northeast-Bydgoszcz, Lodz, Opole, Poznan, and Wroclaw; and northwest-Gdansk, Koszalin, Szcsecin, and Zielona Gora. The 1975-1982 regions were chosen to match the borders of these regions, insofar as was possible (Boyd, 1988). The four zones representing the northwest, northeast, southeast and southwest within this research are broadly similar to those used by Boyd (1988) (see section 5.4.2). However, in a subsequent study, Boyd (1991) used only two regions-east and west.

[159]IV is a standard procedure used to deal with errors-in-variables and with simultaneous equation biases, both of which were significant problems in this estimation. Theoretical arguments supporting the use of lagged dependent variables as instruments in this type of regression are found in Mundlak (1963) and Mundlak and Hoch (1965).

livestock in each sector of ownership. The first equation included six variables: output, land, labour, tractors, horses and fertiliser. The second equation incorporated livestock, a measure for investment, commercial feed supply (see section 4.2.4), a dummy variable to reflect changes in agricultural policy, i.e. increased United States (US) feed grain exports, together with a time trend. The time trend is used to reflect disemboded techical progress (defined earlier in 3.5). The three stage least square (3SLS) estimation procedure was used for regression.[160]

4.2.2 The Polish Context: Output

Boyd (1988, 1991) estimated gross agricultural output (both diary and livestock, fruit and vegetables) in monetary terms at official constant price (1976-1977 average).[161] Data on regional and sectoral production were available from 1975-1982, and this was adjusted using the same, earlier price deflator. However, during 1960-1974, only sectoral and aggregate figures for output were available (segregated into crop and stock production). In these years, Boyd allocated total crop production by the regional share[162] in the production of the four major grains and stock production by regional[163] share in livestock input. The result was that the procedure reflected an output distribution based on observed inputs, one of which was used in the regression analysis, as a dependent variable.

Florkowski, Hill and Zareba (1988) measured annual arable production of four leading crops (barley, oats, rye and wheat) in physical units (1000 tonnes). The objective of the study was to investigate changes in American grain exports on domestic grain production and food supply. Thus other agricultural products, such as sugar, rapeseed and potatoes, milk, yoghurt, eggs, fruit and other vegetables were omitted from the analysis. However, as Ghosh (1971), in his study of Indian farming, emphasised a thousand tonnes of one produce does not equal a thousand tonnes of another produce, in terms of input use (see section 4.4.1). Livestock production was measured

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[160]Although the authors offered no reasoning for using 3SLS in their regressions, it is usually selected when specification of the complete model is made. This implies both zero contemporaneous correlation and all equations within the structural model are exactly identified (Johnston, 1984).

[161]The figures are compiled from data on all farms, excluding the present year and farms which are no longer contributing to agricultural production. The data on vegetables cover all raw (not processed) produce. Data on animals embraces all livestock, including the essential herd for each farm as well as the fish harvest (GUS, 1992f: xxv).

[162]Defined in section 4.2.1.

[163]Op cit.

in 1000 animal units and converted into liveweight to obtain the change in livestock inventories for addition to animal sales (excludes pork). The following weights were used in the transformation to a single index: 600kg per cow; 420kg per beef cattle; 200kg per sow; 100kg per hog and 50kg per sheep. Florkowski, Hill and Zareba (1988) provide no information as to the origins of this weighting procedure; one can only assume that average national weights were used as proxies. Livestock is usually classified as an explanatory variable and is often grouped with 'capital'. However, as the authors wanted to isolate the specific impact of US feedgrain exports to Poland on livestock, and its effects on other domestic variables which included commercial feed supply and farmgrain supply, it was defined as a dependent variable.[164]

4.2.3 The Polish Context: Land

Regional and land quality adjustment[165] were carried out in Boyd's (1988, 1991) analysis using data on regional[166] and national yields. This involved dividing each region or sector average yield for the four main grains (wheat, barley, rye and oats) by the national average yield for the chosen years, and multiplying by the coefficient for the actual number of hectares of working land for each year. In essence this was meant to emphasise the contrasting levels of agricultural output of both the socialised and the private sectors, and in each of the four regions. In contrast, Florkowski, Hill and Zareba's (1988) model of arable production included 'land under cultivation, in hectares for the four major grains'. As there were no efforts made to adjust for land quality, the authors must have assumed that land quality is adequately reflected in harvest yields. Lastly, there have been no references made to either irrigation or melioration in either of these production studies. Perhaps their omission is in response to inadequate secondary data sources.

4.2.4 The Polish Context: Capital

The three conventional variables, livestock, machinery[167] and fertiliser application were quantified

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[164]One of the major problems in any econometric model is the interrelations between both dependent and independent variables, and between independent variables. This is especially apparent in agriculture (Baker interview, 1994).

[165]An unadjusted and a quality-adjusted land data set yielded comparable results in this investigation (refer to section 5.5.2).

[166]Documented in section 4.1.1.

[167]An unadjusted and a quality-adjusted capital data set created similar results in this study (documented in section 5.5.3).

individually in Boyd's (1988, 1991) investigation. Using a methodology devised by Hayami and Ruttan (1971), he aggregated cattle, sheep, swine and poultry into a single livestock index (as described in section 4.4.3). Machinery was defined as the physical number of tractors, multiplied by the average level of 35 horsepower in each sector. However, this figure could be very deceptive especially for larger tractors, with at least a 250 horsepower. Second, the author acknowledged the fact that it was difficult to capture important aspects of agricultural capital as he was hampered by a lack of comparable data for sectoral capital stocks (such as fixed structures). Lastly, he measured fertilisers as 'tonnes of chemical fertilisers consumed' but once again, it was impossible to obtain information on rates of utilisation. Thus, both fertiliser and capital were only partial measures of the input they represented and should be interpreted as proxies for advanced mechanical and chemical/biological agricultural technologies (Boyd, 1988, 1991). The use of organic/home-produced fertilisers which is popular in private Polish farms was omitted from Boyd's study[168], unlike Fan (1991) in his investigation of Chinese agriculture (see 4.4.3).

Similarly, Florkowski, Hill and Zareba (1988) separated their estimates of capital into six distinct categories. In the first model of arable production, they used tractor inventories (mainly for the state), horse inventories for private farms, and fertiliser usage (area planted multiplied by application per hectare). Although the number of horses on private farms has steadily declined, they still make an important contribution to private agricultural production.[169] 'Commercial feed supply', 'farm grain supply, calculated as the residual after subtracting annual sales from production', 'deflated investment credit' (for the private or cooperative sector) and 'new buildings for livestock' for the state sector were used in the second model of livestock production.[170]

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[168]National or voivoidship (county)-level data on organic/home-produced fertilisers are not collected in Poland. In addition, it proved impossible to replicate Fan's (1991) estimation technique because voivoidship (county)-level data collection on horses ceased at the end of 1990.

[169]Approximately 1 million draught horses are still currently in use in Poland, especially on the smaller family farms in the Southern and Eastern regions (Nowicki, 1992).

[170]In both the grain and livestock models of production, some of the independent variables were lagged by one time period. The stock of tractors was lagged by one year, because of the change in tractor stocks in the current year takes place largely after the completion of field operations. In the livestock production function the supply of commercial feed was lagged one year to allow time for livestock to reach market weight and to reflect delays in feed supply (Florkowski, Hill and Zareba, 1988).

4.2.5 The Polish Context: Labour

Both authors applied some form of weighting to account for the qualitative variations in the rural workforce.[171] Boyd (1988, 1991) learnt that the social sector agricultural labour data were presented as 'full-time male equivalent' workers and were available for all years and regions. However, because private sector data were not collected during this period, the author used a combination of data on regional total agricultural labour force and the number of agricultural households to establish the regional labour force in all years. He proceeded to remove the social sector labour from the total and adjusted accordingly. Regional labour-adjustment weights were applied to incorporate the sex and age distribution of the rural population, based on the sex and age composition of the national workforce in those years. However, the author does not divulge the exact methodology adopted in the formation of the weighting index.[172]

Florkowski, Hill and Zareba (1988) were hampered by data unavailability, especially on the allocation of labour between state, co-operative or private farms. Therefore, they estimated the private sector labour force using the 'deflated wage' of the seasonal workforce, and the 'number of livestock or field operation employees' as an estimate of state sector employment. They acknowledged that their division of labour by wage and salary planning was an inadequate measure of labour use, principally because employees may be reallocated to other jobs according to daily needs. However, they preferred using a proxy variable rather than omitting a potentially important variable. Labour data for cooperative farms were, however, unavailable.

4.2.6 The Polish Context: Nonconventional variables

The nonconventional variables, such as education, research, technology and development (RTD) or infrastructure have been omitted from both of these Polish agricultural production analyses. However, Boyd (1988, 1991) integrated 'education' in his quality-adjustment of the labour variable and used an error term to account for weather variations (refer to section 5.6.2). On the other hand, Florkowski, Hill and Zareba (1988) sought to identify managerial variations between the three different sectors prior to estimation. Whilst state-sector and cooperative managers were better educated, in terms of the number of schooling years, they received production targets from

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[171]An unadjusted and a quality-adjusted labour data set generated comparable results in this analysis (detailed in 5.5.4).

[172]I wrote to the author on several occasions but to no avail.

the upper levels of administration making their task more complicated. Also, many state and cooperative farms were too big to be effectively operated by one manager. Private farms were much smaller and private farmers, although often less well-educated, had a very good knowledge of local production conditions. Based upon these facts, the authors assumed the difference in managerial know-how between the private, state and cooperative sectors was negligible.

According to the World Bank, research in Poland is generally of high quality, but it is insufficiently orientated to small family holdings. Furthermore, there are too many agencies involved with overlapping responsibilities. Gaps in research ought to be more clearly identified, and specific priority research areas need to be firmly established. Agricultural Extension Service Centres have had an important impact on the rural environment, but shortcomings exist. Primarily, these failings have been related to a growing emphasis on raising output levels rather than profit maximisation, and the neglect of small-scale farmers (World Bank, 1990). The proximity of research institutions at the local farm level may directly affect diffusion of technological and biological innovation, crop varieties, agricultural mechanisation and so on. The size, organisational structure or affluence of each Agricultural Extension Service Centre in the Polish voivodships (counties) may also influence the development cycle of local farms. For example, those centres situated in Poznan and Western Poland are more likely to attract foreign investment from Germany and The Netherlands, establishing prospective trading links.

Boyd (1988, 1991) also included three dummy variables. The first was for ownership which he denoted as 'one for private' and 'zero otherwise'. The second dummy differentiated between the four regions: northeast, northwest, southeast and southwest. The spatial partitions were based upon materials in Kostrowicki et al. (1978) and the 1960-1974 political divisions.[173] The third was for temporal divisions. Finally, he added an error term for random fluctuations, such as weather (see section 5.6.2). Although, Florkowski, Hill and Zareba (1988) included a 'binary variable' to estimate changes in American feed grain exports to Poland[174] and a time trend in their analysis, they omitted any variable to account for changes in weather.

The following part (containing sections 4.3 and 4.4) provides the methodological context

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[173]Detailed in section 4.2.4.

[174]In the private, state and co-operative model, the variable was set to equal 'one' for the years when government agricultural policy favoured this particular sector (i.e. in 1956, 1968, 1970, 1976 and 1981 for the private sector, 1956-1960 and 1981-1983 for the state, 1955-56 and 1976-1980 for the co-operative). It was set equal to 'one' for 1971-1981 when US exports were in abundant supply, and 'zero' otherwise (Florkowski, Hill and Zareba, 1988).

of earlier non-Polish agricultural production studies which have focused at international, national or regional studies of agricultural supply.

4.3 The International Perspective

As has been noted earlier (section 1.4.2.2 and Chapter 3), the Cobb Douglas production function has been applied to agricultural data at the international, national and local level across the developing and post-industrialised world. Within this theoretical context, there are three general approaches of estimating agricultural output using cross section, time series or panel data. The cross-section approximation was the favoured method contributing to agricultural literature because of both the ease of manipulation from the point of view of statistical estimation and because of economic specification (Ghosh, 1971; Trueblood, 1989; and Yao, 1993). However, the analysis of panel or longitudinal data is now the subject of one of the most active and innovative bodies of literature in econometrics. This is partly because of the theoretical viewpoint[175], but also because researchers are able to examine practical issues which could not be studied in either time-series or cross-sectional alone. For example, cross-sectional production studies provide information on economies of scale (additional notes in Appendix IV), whereas time-series analyses report on both economies of scale and technological change but confuse the two (Greene, 1993).

International surveys have estimated global agricultural production functions ranging from as small a number as nine countries (Wong, 1986), to as large a number as sixty six countries (Antle, 1983). Investigations undertaken from the national and regional perspectives have looked mainly at various agricultural systems in the developing world (LDCs), for example, in regions of India (Ghosh, 1971; Chowdhury, Nagadevara and Heady, 1975; and Bhattacharvya and Bhattacharvya, 1996); in Mexico (Ulveling and Fletcher, 1970); in Pakistan (Zuberi, 1990; and Battese, Malik and Gill, 1996); and in Ethiopia (Yao, 1993). However, other studies have also incorporated the former Communist Bloc countries, including Russia (Brooks, 1983), Eastern Europe (Boyd, 1988, 1991; and Florkowski, Hill and Zareba, 1988; reported earlier) and China (Fleisher and Liu, 1992; and Fan, 1991). Agricultural production studies which have centred on Soviet agriculture during economic transition include those by Johnson et al. (1994) and Brock

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[175]Panel data provides a rich environment for the development of estimation techniques and theoretical results (Greene, 1993).

(1994) (Appendix VIII provides more information).

Agricultural production analyses of LDCs remains a dominant feature of both past and present literature. This seems to reflect the fact that farming still plays a pivotal role in their economic development process, with a large contribution to national output, Gross Domestic Product (GDP)[176], and a high percentage of the labour force actively engaged within this sector.[177] However, farming in the post-industrialised world has not been completely disregarded, and examples of production studies include those on Canadian (Yorgason and Spears, 1971) and US agriculture (Zellner and Richard, 1973).

Of the farming surveys which have been completed, the majority are essentially expansions of the Cobb Douglas approach. At the same time, each model is usually tailor-made to accommodate the objectives of each study. The distinction is largely in response to both the nature and suitability of the agricultural statistics available, but coupled with the rural surroundings of the chosen region or country (Clayton, 1980).

Agricultural supply may be viewed as a process of combining inputs and choice of technology, where 'technology' is classified as a collection of the various techniques utilised for production. These decisions relating to production, allocation, and management are made at the farm level (see Chapter 3). Admittedly, the validity of the formulation of one agricultural production function based upon national data is a tentative area of debate in economics, especially when decisions may be made either by the farmer, or more collectively at the village or regional level. However, to support the applicability of the agricultural production function, one must remember the origins of the data available. In essence, national statistics are derived and compiled from hundreds or thousands of production processes in operation at the regional levels. Furthermore, for any comparative analysis, either within the borders of a country or between countries, a standard method or approach, must surely, be made. The metaproduction function is described as '..an envelope of several production functions..' (Hayami and Ruttan (1971: 82) and as such a number of alternative versions of it exist.

International studies are cross-sectional and generally draw upon the 'meta production'

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[176]For example, the Chinese agricultural contribution to GDP was 19 per cent in 1993 but only 2 per cent in the UK for the same year (World Development Report, OECD, 1995).

[177]For example, 58.6 per cent of the Chinese work force were either formally (co-operative) or informally (family farms) engaged in agriculture in 1993. In contrast, only 2.2 per cent of the UK population were actively involved in the primary sector in the same year (OECD, 1995a; and OECD 1995b).

function hypothesis, as developed by Hayami and Ruttan (1971, 1985) providing a useful framework for looking at global supply and production issues. The hypothesis states:

(i) all countries have access to the same technology;

(ii) each country can produce a given level of output using different factor proportions; and

(iii) human capital allows countries to produce at the technologically most efficient levels[178], at a point in time (Trueblood, 1989).

The model estimates aggregate inter-country production functions, with the implication that 'World agriculture can be represented by a single mode of production' (Trueblood, 1989: 1045). Both economists and non-economists have compiled their own critiques of this fundamental hypothesis. In particular, they argue that aggregate production functions disguise the numerous, alternative micro level production functions which are in place. This problem is especially acute when using very poor quality international information. However, the authors have defended their findings by comparing aggregate level with micro level estimates and have found little disparity between both sets of results (Hayami and Ruttan, 1971, 1985). Indeed, Everson and Kislev (1975), Nguyen (1979), and Yamada and Ruttan (1980) found similar outcomes in their global and local exercises too. For example, Hayami and Ruttan (1971, 1985), on comparing aggregate and per farm results, concluded:

> "..The results from the two sets of data are not sufficiently different to lead to different inferences regarding the agricultural production structures among countries.." (Hayami and Ruttan, 1985 :899).

In general the Cobb Douglas production function has formed the theoretical basis of each study, though authors have varied their functional specification. Whilst Lau and Yotopoulos (1968) used the translog function, Johnson et al. (1994) applied the stochastic frontier approach (outlined in section 3.8). Nevertheless, the traditional factors of production are defined as capital, labour and land. 'Conventional' inputs are land, labour, fertiliser, livestock and machinery. 'Nonconventional' inputs include human capital (education, and research) and state variables (for example, infrastructure, weather and the environment). Dummy variables and time trends have

[178]The technical efficiency of any given resource is defined as the ratio of the product output to the resource input, i.e. the average product of the resource. The greater the product output per unit of resource input, the greater the technical efficiency of the resource is said to be (Eckert and Leftwich, 1988; further details in sections 5.6.1 and 6.5).

been used as proxies for technical progress, seasonal and subsample observations (i.e. LDCs) (Trueblood, 1989).

The earlier inter-country studies were usually characterised with the OLS estimator (Bhattacharjee, 1955; Lau and Yotopoulos,1968; Hayami and Ruttan, 1971; Everson and Kislev, 1975; Nguyen, 1979; and Yamada and Ruttan, 1980). However, since multicollinearity has become an increasingly severe problem in econometric estimation, a few of the authors have employed other methods for regression.[179] For instance, Mundlak and Hellinghausen (1982), Antle (1983), Kawagoe, Hayami and Ruttan (1985) and Wong (1986) applied the Principle Components Regression estimator, as well as the OLS, to limit the adverse effects of multicollinearity (detailed earlier in 3.8).

The observation periods range from 1952 to 1980 at the international level. Whilst the following section concentrates mainly on cross-country variable specifications, it also draws upon methodologies used in national and regional studies for comparison and further qualification. Finally, the difficulties associated with this type of research, such as the most appropriate definition of the output, capital or labour inputs, are emphasised throughout this part (Trueblood, 1989).

4.4 Methodology

4.4.1 Output, as a dependent variable

Bhattacharjee (1955), (22 countries) and Antle (1983), (66 countries) measured agricultural output as the total 'value' in US $ million (net intermediate products[180]) in their meta-production investigations. This implies a value summation of all agricultural produce: an aggregate of arable crops, vegetables, livestock inventories and diary products.[181] Other studies are marginally more specific, estimating output as the total value in million wheat units (net intermediate products). Those who adopted this particular approach in estimation include Lau and Yotopoulos (1968), (43 countries); Hayami and Ruttan (1971), (38 countries); Evenson and Kislev (1975), (36

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[179]Autocorrelation within the OLS disturbance terms meant using a second method of estimation in this study (documented in section 6.3).

[180]These include seeds, etc.

[181]Market prices are generally used as weights on the assumption that these best represent the relative values of different outputs to society. Using prices for some base year, it is possible to measure in real or constant price terms (Thomas, 1993).

countries); Nguyen (1979), (40 countries); Yamada and Ruttan (1980), (42 countries); Mundlak and Hellinghausen (1982), (58 countries); Kawagoe, Hayami and Ruttan (1985), (43 countries); and Wong (1986), (9 countries).

This 'value' estimate for 'output' has also been replicated in regional investigations of Indian, Chinese, Greek and Ukrainian farming. Chowdhury, Nagadevara and Heady (1975) conducted a cross-sectional analysis on the Ferozpur district, Punjab in India, and measured output as the value (in rupees) of desi wheat produced. In a time series study of Chinese agriculture, Fan (1991), investigated Institutional Reform on Production Growth, focusing on twenty-nine provinces, municipalities and autonomous regions, from 1965, 1970, 1975, 1976 through to 1986. He measured 'gross agricultural production value' as the aggregate total output using 1980 constant prices. The subaggregates were: crop production, forestry, animal husbandry and fisheries. Yotopoulos (1968) who centred his cross-sectional estimation in Epirus, Greece[182], measured agricultural output as the 'total value of agricultural production in drachmas, based upon 1964 local prices'. Johnson et al. (1994) analysed Production Efficiency and Agricultural Reform in the Ukraine during the period 1986-1992[183] using panel data on 11,440 state farms.[184] The authors segregated each crop (potatoes, corn, grains and sugar beet), and measured output as 'total cost of production net of wages (thousand rubles)' for each crop-specific model of production (Johnson et al., 1994).

Ghosh (1971) analysed agricultural production across fifty Indian districts and adapted the quantity of goods produced by weighing them against their respective farm harvest prices prior to aggregation (more than twenty-seven different crops were included, but, there was no indication of the exact crops used. Furthermore, livestock plus dairy products were omitted from the summation. Ghosh (1971) admitted that this approach was most unsatisfactory because quantities of different crops even if expressed in a common unit, cannot be validly aggregated. For

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[182]Yotopoulos (1968) collected cross-sectional data from a sample of agricultural households in 110 randomly selected villages and three cities in the region of Epirus, Greece during 1964. The main economic activity was diversified agriculture organised in a number of small, self sufficient, owner-operated family farms.

[183]However, the financial data for 1992 was around fifteen to twenty times higher than for the previous six years, apparently attributable to inflation. Because of the lack of a suitable price deflator, the panel analysis excluded data for 1992 (Johnson et al., 1994).

[184]The data accounted for 89 per cent of the agricultural land (36 million hectares). To retain natural productivity differences, the Ukrainian data were divided into three agro-climatic zones: the steppe zone (annual average precipitation between 350 and 450 mm); the forest region (annual average precipitation between 600 and 700 mm) and the mixed zone, representing the largest area (Johnson et al., 1994).

example, one tonne of black pepper, potatoes or tobacco is quite different (in terms of inputs) from one tonne of wheat[185] (detailed also in section 5.5.3). On the other hand, potatoes may probably yield 4-5 tonnes per hectare of Indian land, and wheat less than half a tonne, yet their values may be quite similar. However, he also stressed that this was the only used method of aggregation available at that particular point in time. An alternative solution offered by Ghosh (1971) was to measure the value by using national prices which are more appropriate than state prices, simply because there was a degree of market imperfection at the regional levels.

Fleisher and Liu (1992) looked at the relationship between efficiency and the size of family plots in Chinese agriculture.[186] They measured 'production' as the aggregate family output, in weighted rice equivalent kgs. The weights were based on the price parity ratio of agricultural and industrial products in the Statistical Yearbook of China, 1987.[187] The crops included aggregate wheat, corn, rice, millet, sorghum, sweet potatoes, cotton, soybeans and peanuts. Fruit and vegetables were excluded because of difficulty in measurement (documented also in section 4.4.2).

In contrast, Cornia (1984, 1985) collected information between 1973-1979 on at least 18 developing countries (3,167 farms) and measured output as the total value of farm output plus an estimate of the farm value added. This was later transformed into 1970 US dollars. The national figures were converted into 1970 US domestic prices by means of the implicit price deflator of the agricultural value added, and then converted into dollars using the 1970 exchange rates. Similarly, Ulveling and Fletcher (1970) performed a cross-sectional study of individual farms in an irrigated area of Mexico. Output was measured as the value of farm crop production in pesos.

An alternative methodology is one which focuses primarily on the physical level of agricultural output. This is usually in response to problems associated with either the accessibility,

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[185]For example, one hectare of United Kingdom (UK) land produces an average seasonal crop of 7 tonnes of wheat and requires 220 kg of nitrate, 60 kg of phosphate and 60 kg of potash (3.67: 1: 1). One hectare of UK land produces an average seasonal crop of 40 tonnes of potatoes and requires 210 kg of nitrate, 250 kg of phosphate and 275 kg of potash (1: 1.19: 1.31) (Saxby, 1996).

[186]Fleisher and Liu's (1992) cross-sectional study on 'Productivity of Chinese Agriculture' used data which was collected during 1987-88 incorporating 1,200 farm households across six distinct geographical regions of China (Fleisher and Liu, 1992).

[187]For example, based upon the average purchasing prices in 1986, 100kg of wheat was approximately equivalent in value to 153kg of salt, which has an almost uniform national price. 100kg of rice was equal in value to 116kg of salt. Therefore the ratio 153/116 = 1.319 is the aggregation weight in terms of rice (Fleisher and Liu, 1992).

availability, suitability, and reliability of national agricultural data or problems of multicollinearity. For instance, Zellner and Richard (1973) conducted a time series investigation of the agricultural sector in the US economy and measured output as real aggregate output. Yao (1993) analysed cereal crop productivity in Ethiopian agriculture using time series data during 1981-1987. Production was estimated directly, because of highly inconsistent price, input and product coefficients (as is the case in this study; see section 5.5.1). The major food crops used were: teff, wheat, maize, barley and sorghum which were estimated both individually and aggregated together as a 'single product'. These products formed 95 per cent of the total cereal production (Yao, 1993). Battese, Malik and Gill (1996) also quantified their output and inputs in physical terms in their analysis of farming in four districts of Pakistan during 1986-1991. However, they did not offer any explanation in doing so.

In summary, there are two general ways in which the dependent variable has been estimated in earlier empirical analyses: in monetary value or in physical units. Elaborations on the first approach include weighting systems to genuinely reflect harvest yields using current national or local price indices. The chosen method of estimation is usually related to the nature, quality and availability of national or regional data; the aims and scale of the study; and the likelihood of market imperfections. Any estimation of this kind has its limitations and undervaluation is quite possible. Lastly, other external factors effecting the production of staple crops could be reflected in resource constraints, political choices or consumer tastes (Trueblood, 1989).

4.4.2 Land as a 'conventional' independent variable

Over the years a number of procedures have been developed to quantify the input 'land' at all three levels of spatial investigation. In the earliest empirical metaproduction study, Bhattacharjee (1955) used 'weighted arable land, in 1000 hectares.' However, other authors have attempted to differentiate between the types and quality of land effecting agricultural output and so, alternative definitions have arisen. For instance, via the differentiation between irrigated and unirrigated soil; pasture and arable; cultivated and fallow, and through crop selection.

The majority of international investigations aggregate 'arable and pasture land, in 1000 hectares' when modelling agricultural output (Lau and Yotopoulos, 1968; Hayami and Ruttan, 1971, 1985; Everson and Kislev, 1975; Nguyen, 1979; Yamada and Ruttan, 1980; Mundlak and Hellinghausen, 1982; Antle, 1983; Kawagoe, Hayami and Ruttan, 1985; and Wong, 1986).

Similarly, Fan (1991) combined data for 'sown' and 'pasture' to measure land input because of the degree of inaccuracy in arable land data for his analysis of Chinese farming. Under the same principle, further differentiation could be made between land under permanent or temporary cultivation and specific arable crops at the farm level.

When Chowdbury, Nagadevara and Heady (1975) studied the supply of Indian agriculture, they measured land as the area of a farm under wheat production, in hectares, because this was the dominant crop grown. In fact, the excluded items accounted for less than 5 per cent of the total crop area. Fleisher and Liu (1992) defined land as the 'family crop area measured in mu[188] and included the total crop area planted. However, another alternative may be to define land as 'land area under cultivation for each specific crop' as in Johnson's et al. (1994) study of Ukrainian farming and Yao's (1993) investigation of Ethiopian cereal crop production. As for the latter, 95 per cent of the total cereal production was accounted for.

Finally, the most popular method of incorporating the quality of soils within a production model is to include a measure for irrigation. Cornia (1984, 1985) estimated 'land' as the proportion of irrigated land per farm, and land inputs were expressed in hectares only, as it was impossible to account for variations in land quality by pricing the various types of farmland. Kawagoe, Hayami and Ruttan (1985), in addition to distinguishing between arable and pasture land, also chose to differentiate between the ratio of irrigated land, and total land area to adjust for differences in the quality of land input. Ghosh (1971) mirrored this method in his analysis of fifty districts in India. However, the authors found that not only could there be high complementarity between irrigation and fertiliser use but also the productivity rates were subject to the different seasons, and hence the supply of water for irrigation. Zuberi (1990), who focused on agriculture in Pakistan, using a time series approach, measured land cultivated at a particular time period.

In summary, earlier empirical research has shown that a truly quality-adjusted land variable has been particularly difficult to achieve. According to Trueblood (1989) irrigation plays an important part in farming across most parts of the world, but has not proved a significant independent variable. On the contrary, Ghosh (1971) in his study of Indian farming did in fact prove it's significance in the agricultural production cycle. Furthermore, land use might be interrelated with the chosen crop or crops. For simplicity, land quality might be assumed to be

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[188] 1 mu=0.1647 acre=0.07 hectare.

reflected in crop yields.

4.4.3 Capital as a 'conventional' independent variable

Capital itself, may be measured as a group variable or as individual estimates to include livestock, fertiliser, machinery, seeds or farm buildings. The inter-country studies have usually segregated livestock, fertiliser and operational capital, such as tractors and horsepower, into separate independent variables and measured accordingly. 'Livestock' may be computed using an 'animal equivalent weighting scheme', here the weights are used to aggregate animal inventories to construct a single valued stock input variable. These were: camels (1.1); cattle (0.8), horses (1.0), swine (0.2), sheep and goats (0.1) and poultry (0.01)[189], as devised by Hayami and Ruttan (1971). Fertiliser is usually defined as the gross weight of total consumption of the concentrate, i.e. nitrogen, phosphate and potash and is measured in kilograms, tonnes or 1000 tonne units. Whilst Bhattacharjee (1955) measured operational capital as the 'number of tractors', other authors converted all tractors into horsepower equivalent (Bhattacharjee, 1955; Lau and Yotopoulos, 1968; Hayami and Ruttan, 1971, 1985; Everson and Kislev, 1975; Nguyen, 1979; Yamada and Ruttan, 1980; Mundlak and Hellinghausen, 1982; Antle, 1983; Kawagoe, Hayami and Ruttan, 1985; Wong, 1986; and Boyd, 1988, 1991; Appendix VIII contains more detailed information).

Similarly, national analyses by Yotopoulos (1968), Yorgason and Spears (1971), Ghosh (1971), and Fan (1991) separated the capital inventories according to data availability and study objectives. Yotopoulos, in his analysis of Greek farming, (1968) divided the variables into the value of current services of live capital in drachmas of the following: operating expenses for live capital; value of current services of plant plus operating services (houses, irrigation and ditches); and the value of equipment (tractors and implements). Yorgason and Spears (1971) divided capital into 'fixed capital', including implements, machinery, farm buildings, livestock and poultry; and 'operating capital' defined as the goods and services used by farmers in production with the exception of labour and living costs. Fan (1991) measured capital as the total horsepower at year end. Livestock was treated as a dependent variable. Ghosh (1971) classified capital as 'animal power' and 'mechanical power', subdividing again into 'male total of cattle and buffaloes' plus the total of all other animals. He then converted this figure into 'animal-days', in a similar way to man-days for labour (documented in section 4.4.4). 'Mechanical power' included two types of plough:

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[189]The aggregation weights were taken from FAO Yearbook data, reported in 1971.

wooden and iron, where the latter was distinguished as the better of the two, plus the number of tractors.

In contrast, Cornia (1984, 1985) grouped capital as machinery, cattle and orchards together, excluding the value of land and including half the value of buildings (on the assumption that half of the buildings were used for lodging and the other for storage). Fertilisers, fuel, seeds, and pesticides were grouped as a separate variable. Likewise, Ulveling and Fletcher (1970) grouped capital services related to seed, fertiliser, and other seed treatments; and capital services from machinery and other machine related expenses together in their research of Mexican peasant farming. Fan (1991) included an estimate of manurial fertilisers, an important explanatory variable, when he studied Chinese agriculture. This incorporated animal, human, and crop wastes; green manures; and water plants and was measured from both the agricultural population (human waste) and the numbers of domestic animals.[190] Fleisher and Liu (1992) defined capital as 'monetary expenditure on pesticides, seeds, hired machinery and hired animals.' Fertiliser was kept as a separate variable, and defined as the 'monetary expenditure on purchased fertilisers.'

An alternative representation, as devised by Chowdbury, Nagadevara and O'Heady (1975) and Zuberi (1990), is when the monetary value of seeds and fertilisers (owned or purchased) is used as a proxy for capital flow. Hence, both fixed and operational capital along with the livestock variables are excluded from the estimation process. Inconsistent, unreliable or unavailable data may account for the omission of such 'conventional' variables, or quite simply, the farmers in the study areas of India and Pakistan just did not have access to these resources. Indeed, Ghosh (1971) dismissed the use of chemical inputs (insecticides, pesticides and fertilisers), manure and improved seeds in his research of Indian farming because the relevant data at district level were unavailable.

Therefore, evidence from earlier studies illustrates the simple fact that data availability has usually determined the precise measurement of this conventional variable. Furthermore, authors have needed to decide whether to treat capital as a grouped or a separate independent variable, depending on the objectives of the study. It is worth noting that the increasing number of independent variables within a model raises the probability of the existence of multicollinearity

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[190] FAO estimated that one animal (horse unit) produces about 4 tons of manure per year and a person produces 0.25 tons per year. Manure contains 2.2 per cent pure nutrient, and the manure availability is about 75 per cent of total use. Hence, annual manurial resources (tons) = ((1.25 x rural population) + (4 x number of livestock)) x 2.2 per cent x 75 per cent (Fan, 1991).

which may result in statistically insignificant variables (t-ratio <±2). In fact, the models derived usually attempt to limit the number of independent variables to avoid this statistical problem as far as is possible (Kawagoe, Hayami and Ruttan, 1985).

Accurate estimation of the flow of capital, using index numbers, causes more problems than the evaluation of either the output or the labour variables, principally because of innovation over time and the existence of technological progress (detailed in section 3.5). Old machines become obsolete and provide inferior services to new up-to-date machines. Whilst the figures may be displayed in gross value or discounted for depreciation[191], invariably their presentation is far more rudimentary, especially in developing countries. Moreover, the data usually measures 'capital' in terms of stock equipment, thus variation in utilisation[192] becomes important because it will directly effect the so-called capital flow of services. Other criticisms include large tractors today have horsepower equivalent which is at least 250 HP, contrary to 30 HP, under Hayami and Ruttan's (1971) assumptions. Finally, perhaps a combined capital input variable, encompassing tractors and draft animals would better reflect the true value of the flow of capital services (Trueblood, 1989; and Thomas, 1993).

4.4.4 Labour, as a 'conventional' independent variable

According to earlier empirical research, the effective estimation of labour inputs divides into three basic categories: the 'stock' number of workers, 'man-days (man-years)', and the 'deflated wage'. Bhattacharjee's (1955) global agricultural production function defined labour as 'all agricultural labourers'. Similar measurements were employed in local scale analyses, including those by Yorgason and Spears (1971), Zellner and Richard (1973), Zuberi (1990) and Fan (1991). However, 'Male agricultural labourers' has proved the most popular technique implemented across international production studies (Lau and Yotopoulos, 1968; Hayami and Ruttan, 1971, 1985; Everson and Kislev, 1975; Nguyen, 1979; Yamada and Ruttan, 1980; Mundlak and Hellinghausen, 1982; Antle, 1983; Kawagoe, Hayami and Ruttan, 1985; and Wong, 1986).

However, other authors have digressed from the three primary procedures. For example, Ghosh (1971) distinguished between owners of farmland, classed as 'cultivators', and 'hired

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[191]Other costs include opportunity cost.

[192]Attempts have been made to adjust for the varying rates of utilisation by using 'unutilised' labour statistics, but this method assumes that the utilisation of capital is identical to labour utilisation (Thomas, 1993).

labourers', thus creating two separate independent variables. Both sets of data were differentiated further by age, sex, education (literate or illiterate) and origin (urban or rural) (expressed as a percentage). However, integrating such a large number of independent variables within a model may actually result in increasing the probability of multicollinearity occurring. The 'cultivators' variable was measured as the number of workers present, but the 'hired labourers' was expressed as man-days multiplied by the average number of working days per year.

The second most popular approach documented is to measure the 'labour input' in hours (or units of), (Ulveling and Fletcher, 1970; and Johnson et al. 1994), man-days and man-years (Chowdbury, Nagadevara and Heady, 1975; and Cornia, 1984, 1985). Although additional categorisation may result in the incorporation of both hired and seasonal labour, as carried out by Fleisher and Liu (1992) in their analysis of Chinese family farming or farm managers, as in the study by Johnson et al. (1994).

Since there are many types of 'labour' input (male and female, skilled and unskilled), ideally some weighted measure of total labour input should be derived to fully account for its heterogeneity. One way to adjust for quality is to use some weighted measure for total labour input. Appropriate weights would be base-period hourly wage rates for the different types of labour, provided that these wage rates adequately measure the relative usefulness (if available) of the various labour flows in the production process. Base-year wage rates need to be used if labour inputs are measured in physical or 'constant price' terms and abstract from any changes in the value of labour inputs which arise simply because of changes in its price. However, problems may still arise if the quality of labour changes dramatically over time, and there is still the problem of which base year to select. In practice, this procedure is often approximated by aggregating the money value of labour inputs and deflating them by an available index of labour input prices. This is the third most popular approach documented, known as the 'deflated wage' (Thomas, 1993).

The major criticism of the ways in which labour flows are measured is the fact that they invariably omit women from the analysis (Trueblood, 1989). The traditional function and status of women in the developing world (particularly in Africa and the Far East) places them at the centre of agricultural systems, yet their pivotal role often goes unacknowledged, by local communities, experts and indeed, Non-governmental Organisations. Secondly, as Bairam (1991) indicated in his study of Russia, labour services can deviate from the number of persons employed due to either underemployment or adjustment of the length of the working week. Finally, there is always a high element of inaccuracy, particularly with this variable, in the compilation of data as farmers may report working longer than they actually do (Chowdbury, Nagadevara and Heady, 1975). Once again, any method devised to accurately quantify labour inputs is restricted by the availability and suitability of relevant statistics. This is especially characteristic of transitional economies (refer to section 5.2). For example, Polish data on either the agricultural labour employment (family, hired, seasonal or otherwise) or agricultural labour wage indices were quite simply, never collated in 1990/1 (private sector) and in 1990/3 (former) state sector) (documented in section 5.5.4).

4.4.5 The 'nonconventional' independent variables

The 'nonconventional' independent variables include education and RTD; and 'state' variables, such as infrastructure, weather and the environment.

Of the metaproduction studies which incorporated such measures, Bhattacharjee (1955), Lau and Yotopoulos (1968), and Antle (1983) all used 'literacy ratio (in percentage)' as a measure for general education.[193] Lau and Yotopoulos (1968), Hayami and Ruttan (1971, 1985), Everson and Kislev (1975), Nguyen (1979) and Kawagoe, Hayami and Ruttan (1985) used two separate measures for education which were 'school enrolment at the primary and secondary level during the estimation period (in percentage)'. On the other hand, Nguyen (1979) used 'school enrolment at the secondary level (in percentage)' only for the period under investigation. Technical education[194] was reflected by the 'number of graduates per 10,000 farmers' (Lau and Yotopoulos, 1968; Yamada and Ruttan, 1980; and Kawagoe, Hayami and Ruttan, 1985), and by the 'number of graduates involved in research and extension per 10,000 farmers' (Nguyen, 1979). Primarily, this is a way of reflecting the national capacity for research, and an indication of management possibilities.

A number of national studies have also used education as an additional indication of the quality of the farming labour force. Fleisher and Liu (1992) introduced two independent variables into their model, which were the 'respective years of schooling' and 'years of farming experience.' However, data limitation ultimately restricted the analysis to the 'head of the household' only. Yotopoulos (1968) expressed education as an index, calculated as the sum of the years of

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[193]This is intended to measure the decision-making capacity of farmers (Trueblood, 1989).

[194]The inclusion of this variable is to indicate the ratio of agricultural advisers to farmers (Trueblood, 1989).

education of all farm household members in the age bracket 15 to 69, divided by the number of farm household members in this age bracket. The reason for concentrating on the education of members in this age bracket was that these members were more likely to participate directly in farm activities or to transfer their education to the household members who do the agricultural work (Yotopoulos, 1968).

Regardless of these efforts, it has proved relatively difficult to ascertain the direct effects of education on labour productivity and its impact on the level of agricultural output. Nevertheless, a number of empirical studies have linked growth in LDCs with growth in the factors themselves, aided by improvements in the quality of labour through health and education (Hagen and Hawrylyshyln, 1969; Nadiri, 1972; Maddison, 1970; and World Bank, 1991). However, farm and local characteristics may be additional externalities which also influence the productivity of labour. For example, in the remoter areas of LDCs, where the predominant form of education is handed down from generation to generation, the 'literacy ratio (in percentage)' may play a diminished role in labour productivity. However, on the larger, technologically advanced farms, the levels of general and technical education will have profound effects on the labour: capital ratio. In addition, although estimates of technical and general education[195] may be valid in their own right, there are, nevertheless, only proxies, which can prove misleading[196] (Trueblood, 1989).

A proxy for research has been integrated within metaproduction investigations, as measured by the 'number of scientific publications over the specified time span' (Everson and Kislev, 1975; and Antle, 1983) or by 'Government allocation to research agencies' (Wong, 1986). When research has been included in these models, it has proved to be a statistically significant independent variable (t-ratio $>\pm 2$). Even so, it is very difficult to fully capture diffusion and adoption has not been too successful, at the present time (Trueblood, 1989). To date, there have been no attempts made to estimate the role of 'research' in either national or regional agricultural production analyses. Nevertheless, researchers throughout the world have consistently found the social rates of return to agricultural research to be among the highest of public investments (eg.

[195]Primary education has led to improved farm efficiency (Lockheed, Jamison and Lau, 1972), but general education has been a weak independent variable at best (Trueblood, 1989).

[196]For example, it is unclear whether there is an even correlation across countries between labour productivity and the ratio of agricultural students against all students; enrolled students against graduates; and agricultural graduates against extension workers (Trueblood, 1989).

Kawagoe, Hayami and Ruttan, 1985). Indeed, the role of research in agriculture stimulates technological advance, releasing the constraints on production imposed by natural resources and human labour, typifying a shift from 'a resource based sector' to a 'science based industry' (Ruttan, 1982: 3).

Infrastructure was reflected by the 'portion of GDP spent on transportation and communications' in Antle's (1983) global production study of 66 countries. Once again, this independent variable has been omitted from both national and local level investigations.

Dummy variables or time trends are usually incorporated within the cross-country and national models to account for stochastic disturbances, such as weather (Boyd, 1988, 1991) or for regional and temporal variations in output from policy changes (Florkowski, Hill and Zareba, 1988; and Fleisher and Liu, 1992) and subsample observations, such as LDCs (Kawagoe, Hayami and Ruttan, 1985). Although any number of dummies is permissible, occasionally they are statistically insignificant when regressing as a result of multicollinearity. Secondly, a linear time trend may be included to account for technological and other changes over time (Florkowski, Hill and Zareba, 1988; and Johnson et al., 1994; detailed also in 3.5 and 4.2.1). Finally, agricultural support is a common phenomenon of the agricultural supply network, particularly in the post-industrial economies of Western Europe and the US. Yet, the role of quantitative policy variables, such as the consumer subsidy equivalents and producer subsidy equivalents have not yet been incorporated within the general framework of global, national or regional farming production examinations (Trueblood, 1989).

4.5 Summary

Chapter 4 has provided an overview of popular methodologies used to model the supply of agricultural produce. Local agricultural production studies of a region or country, combined with global investigations between countries have yielded an assortment of variable specifications. This is largely in response to limitations associated with either local or national agricultural data sources. To overcome secondary source data restrictions, a number of authors collected primary source material, such as a series of farm-by-farm interviews, to complement the quantitative aspects of their studies (Yotopoulos, 1968; Boyd, 1988, 1991; and Johnson et al., 1994). Other ways of adjusting for variation in the quality of inputs within a largely numerical context is through the use of weighted indices (see earlier sections 4.2.3, 4.2.4 and 4.2.6). Lastly, accurate data collection was (and still is) especially difficult in Central and Eastern Europe and in the Former Soviet Union because of both the bias towards the state-owned enterprises and incompatible data representation. In fact, modelling on any aspect of a transitional economy is proving exceptionally difficult (Brock, 1994; Johnson et al., 1994; and Bartholdy, 1995).

Chapter 5

The Cobb Douglas Model of Polish Arable Production during the early years of economic transition

5.1 Introduction

Chapter Five is in three parts. First, the nature of Eastern European and Polish data are explored (sections 5.2 and 5.3); second, the methodology and the specification of each conventional variable used in this arable production model (output, land, capital and labour), together with recent trends in factor resources are highlighted (sections 5.4 and 5.5); and third, the use of nonconventional variables, including farm size and weather are presented (section 5.6).

5.2 East European data: some caveats

Inaccuracy in both the definition and measurement of macroeconomic data are common problems associated with the collection of statistics in every country of the world. Miscalculation occurs when either national accounting concepts fail to correctly define a particular transaction or when a methodological error is made. For example, in data sampling or in the conversion of raw price/volume data into indices. Moreover, when a country is experiencing fundamental changes in its economic system as is the case of Poland, the difference between the 'true' values of economic variables and the 'official' values becomes even more acute.[197] In the pre-reform years, statistics on production volumes generated by Central and Eastern European countries (CEECs) and the Former Soviet Union (FSU) were largely based upon information from state-owned enterprises. Virtually all of these companies were subject to extensive reporting requirements (Bartholdy, 1995). Since 1989, smaller private entities have made substantial contributions to economic growth and activity and as such, statistical agencies began to use survey-based methods of data collection similar to those in the West to monitor their development. However, the change of technique has only compounded the already existing methodological difficulties (Bartholdy, 1995).

Over the last seven years, Eastern European statistical agencies have been gradually phasing out their centrally-planned approach to national accounting, the Material Product System (MPS), which excluded many services (in the so-called 'non-material sphere') from the 'Net Material Product (NMP), its main measure of value added. The aim has been to replace the

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[197]The most renowned example of this pertain to statistics for output and value added (Bartholdy, 1995).

Material Product System with the United Nations' System of National Accounts (SNA), and so establish the essence of the standards that are applied in most Organisation for Economic Cooperation and Development (OECD) member states and developing countries throughout the world. Nevertheless, controversy still remains with regard to the relationship between the NMP value and the estimate of Gross Domestic Product (GDP). In fact, definitional uncertainty resulted in certain statistical agencies of the Commonwealth of Independent States (CIS) using 'old' data collection for the NMP value and multiplying by a fixed factor (between 1.1 and 1.3)[198] to account for the exclusion of service-sector activity from the NMP value, and so create a 'new' estimate for GDP (Bartholdy, 1995).

Most of the countries within this region have recently experienced very high inflation, making the task of measuring relative price changes particularly arduous. Notably, high inflation has also made it difficult to correctly deflate nominal data for production, use of inputs, consumption, fixed investment, stock-building and investment. In addition, indexation is yet another factor which has complicated the interpretation of price (and production) data for CEECs and the FSU. One important aspect is in the choice of base year. For example, the Federal Czech Republic still presents its national accounts at 1984 constant prices which means the prices of pre-reform years continue to distort the growth rate of post-reform years. Another very important aspect relates to quality improvements. Part of the price increase that has taken place in recent years in CEECs and the FSU has been caused by the switch from low quality cheap products to high quality equivalents. In some cases, estimates of changes in production volume which may have been deflated using these exaggerated price indices, could result in an underestimate of a production increase or an overestimate of a production decline (Bartholdy, 1995).

Finally, the restructuring and policy decisions in these formerly planned economies are occurring with little support from empirical analysis of the impacts of the reform process. Micro-level data is limited, and few economists have had the opportunity to produce the analysis required to advise on difficult policy decisions concerning the scope and sequencing of the economic reforms. For example, efficiency analysis of agriculture, to date, has been limited to highly aggregated data, as is the case here (Johnson and Brooks, 1983; Koopman, 1989; and Johnson et al., 1994).

Post 1989 official Polish statistics are considered relatively reliable, in comparison with

[198]An ad hoc estimate, with little empirical justification.

other post-communist countries (Rostowski, 1993). However, during the period of hyperinflation (1990-1991), data on certain variables were never actually collected (for example, the private sector agricultural labour force; detailed in section 5.5.4). Despite, a renewed commitment by the Polish authorities towards the standardisation of statistical materials, different interpretations of statistics even between Polish economic sectors has made the task of modelling more demanding. Thus, whilst Boyd (1988, 1991) and Florkowski, Hill and Zareba (1988) experienced problems with data availability in their studies of Polish farming, access to the appropriate data sources was as much a problem then, as it is today.

5.3 Polish agricultural data sources

Annual panel data from the 49 Polish voivodships[199] (counties) during 1988-1993 inclusive, were extracted from a number of secondary sources published by the Central Statistical Office (GUS), Warsaw, Poland.[200] Data consolidation included a comprehensive investigation of all statistical materials available in both the GUS archives and statistical libraries of Warsaw and Lodz, together with a series of face-to-face, semi-structured interviews with a number of GUS departmental employees.[201] However, voivodship (county) level data proved particularly difficult to assemble and as such, certain data sets remained incomplete.[202] Data omission resulted in data intrapolation and extrapolation prior to regression[203], and unfortunately, even one independent variable had to be excluded from the production analysis.[204]

In addition to voivodship (county) data collection, a farm-level survey was carried out in two study areas (Wagry and Rzgow)[205] during summer 1993 and autumn 1994, and micro-level

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[199]As defined previously in sections 1.3 and 4.2.1.

[200]Having been unsuccessful in acquiring the data on disc at several of the departments of the Ministry of Agriculture, Warsaw.

[201]The interviewees included experts in Private and (former) Socialised Agriculture, Rural Population, Income and Employment.

[202]This was simply because the data were never actually collected (GUS delegate, 1994).

[203]Estimation of the private and (former) social sector labour force data sets is documented in section 5.5.4.

[204]Data on the size of former state farms were available for 1993 only; it was impossible to obtain any information during the period 1988-1992 (documented in section 5.6.1).

[205]Detailed in section 1.4.2.

data were compiled on the respective 'output' (product) and 'input' (factor) flows in the regional agricultural production processes. The information which was gathered related to the average annual harvest yields of the main agricultural products produced on each farm (including arable, diary, fruits and vegetables); land quality[206]; farm size, distribution of plots and arable land under cultivation. Details of labour resources consisted of the age and standard of education of the head of household, present occupation (part-time or full time farmer); the number, sex, age and education of dependents; number of farm workers (family, seasonal or otherwise), and the respective wage levels. Knowledge of capital inventories included the age, quality and utilisation of tractive force, origin and application of fertilisers and age and number of arable and diary livestock. Other details on the local infrastructure; destination of farm produce (farm, local region or the city (Koluscie or Lodz) and the private and (former) state farmers' attitudes' on the change towards the market economy completed the empirical fieldwork. The survey encompassed 170 private farms, together with two (former) state-operated farms in total. However, inconsistency in the survey results combined with a small sample size resulted in a localised distribution, unrepresentative of the dynamics at either the regional or national level. Therefore, these results were omitted from the econometric analysis. Nevertheless, lengthy discussions with Polish private farmers, their spouses and children, combined with (former) state-farm managers provided very useful ad hoc information relating to each agricultural region.

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[206]Polish land is classified by the Polish Ministry of Agriculture, divides into six categories (Classes I to VI) and is based upon the quality of soils, height, slope, climate, drainage, the existence of trace elements, and the capability of agricultural production (United Kingdom (UK) land classification separates into five categories). The best soils are those with the highest fertility, good physiography and structure, and the poorest soils are those of low fertility, fit only for afforestation.

Poland's agricultural sector has 18.72m hectares of arable land which comprises approximately 60 per cent of the country. It's topology is generally flat and favourable to farming (Econolynx International Ltd, 1990). An estimated 30 per cent of Poland's arable lands have soils that are rated as good, but an additional 30 per cent have mostly light textured soil of low natural fertility, often with a high water table requiring drainage. Soil acidity is a serious problem in more than 60 per cent of the soil. Careful management and proper fertiliser application is required for optimal crop production. Polish scientists estimate that the overall agro-ecological conditions are about 30 per cent less favourable to crop production than in most Western European countries (Econolynx International Ltd, 1990).

For a UK comparison, over 80 per cent of agricultural land in Wales and Scotland is in the poorest two grades, with little potential beyond sheep and cattle rearing, while in England the figure is only 26 per cent. Furthermore nearly half the eastern region of England lies in grades I and II (Burrell, Hill and Medland, 1990).

5.4 Methodology

5.4.1 Ownership

The data are differentiated on two counts: ownership[207] and region. The private[208] and (former) state[209] owned sectors of Polish farming are treated as separate agricultural systems, differing in structure and organisation, performance and stages of agricultural development (see also sections 1.4.2.2, 1.5, 2.2 and 2.3). The inherent structural nature of farming in Poland necessitates two alternative responses to economic transition. For example, whilst plot consolidation is cited as the most important structural change for the private family farms, privatisation and property rights are essential prerequisites in the redistribution of the land resources which fell under the control of the state (detailed in 1.4.2.1). In contrast with other CEECs, private farming is especially important to the primary sector of the Polish economy (see sections 1.1 and 2.4; Agra Europe, Special Report No. 56, 1990). Ironically, the Polish peoples' ardent desire to 'cling to their land' is likely to have a detrimental effect on the future prosperity of Poland, as it fully embraces the market-oriented economy (Borek, Reed, Szemberg and Wierczorek interviews, 1993/4; and Kuba, 1996). Whilst only 6 per cent of private farmers wished to increase their farm acreage, only 2 per cent were willing to decrease the size of their farmsteads over the period 1993-1996. The overall effects have been a slow rate in farm consolidation and a sluggish evolution of larger-sized, more efficient farms (Szemberg interview, 1994, further documentation in section 7.2.3).

In 1990, the Agricultural Property Agency of the State Treasury (APA) was created to 'take hold of the assets of the liquidated State agricultural enterprises, transferring them to the

[207]Data segregation in terms of 'ownership' was terminated at the end of 1993. Since 1994, GUS has been registering harvest yields in aggregate.

[208]This is defined as 'Indywidualne Gospodarstwa Rolne', which include individual agricultural concerns, i.e. farms of an area of over 1 hectare of land dedicated to agriculture, tended by farmers on land which is their own or otherwise. Individual allotments of area up to 1 hectare of usable land dedicated to agricultural work by the private individuals, e.g. company allotments, employee allotments and farms belonging to the individual owner of farm animals who do not possess agricultural means. This is the largest contributor to agricultural production in the private sector. This was adopted largely because there were data available on all the other variables, and hence married well with agricultural output (GUS, 1992f).

[209]This is defined as 'Wlasnosc Panstwowa' which include nationalised farms (businesses) of which the founding father is the Minister of Agriculture and Food Economics or the Wojewoda (Sheriff); these farms are presented under the heading 'National farms answerable to (responsible to) the Ministry of Agriculture and Food Economics and Sheriffs', abbreviated to 'pgr podporzadkowane Min RiGZ oraz wojewodom'. Secondly, farms of non-agricultural concerns, i.e. remaining businesses, partnerships and other nationalised farms working in agriculture (jointly with small agricultural structures) (GUS, 1992f).

Agricultural Property Stock of the State Treasury' (APA, 1994: 1). The APA[210] took over assets comprising of 3, 028, 232 hectares of land[211] and 275, 015 flats. Out of the 3, 300, 031 hectares of land which were transferred under the jurisdiction of the APA, 71 per cent had remained in the stock at the end of 1993, 27 per cent had been leased but less than 2 per cent had been sold outright[212] or transferred gratuitously.[213] 174, 515[214] persons were employed in 1,350 farms on the day when their assets fell under the control of the Agricultural Property Stock. After restructuring, total employment fell by 67, 949 persons (38.9 per cent). Among them, 27, 650 found alternative employment at the farms of new owners or lessees (40.7 per cent), 5, 819 went on pension (8.6 per cent), 34, 480 were either dismissed or refused to work for the new owners or lessees (50.7 per cent)[215] (APA, 1994: 2; confirming Hypothesis 1, section 1.5). At the regional level, the APA's role was conducted through 15 offices[216] (detailed in sections 2.5.3 and 7.2.3).

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[210]The restructuring programmes have determined the relevant disposal of state-owned enterprises. Five alternative ways of disposal have been devised. First, the sale of farms, plots of land and other assets; second, lease or tenancy; third, the transformation of the assets into companies, created only by the Agency or with other partners; fourth, entrusting the property to state organisational entities without a legal personality for management or fifth, assigning the property to an administrator designated by the Agency for a specified period (APA, 1994).

[211]This is equivalent to 7.3 per cent of Polish territory (Econolynx International Ltd, 1990).

[212]67.9 per cent of all the land sold was located in the north western region of Poland. 12.2 per cent was located in the southeast, 11.0 per cent in the northeast and 8.8 per cent in the southwest (APA, 1994; refer to Table VI.1, Appendix VI).

[213]54.3 per cent of the land given away free of charge was situated in the northwest. 38.3 per cent in the northeast, 5.4 per cent in the southeast and 2.3 per cent in the southwest (APA, 1994, see Table VI.1, Appendix VI).

[214]It is acknowledged that the index used to measure state sector employment in this study may have overestimated labour's contribution to agricultural production by 23, 585 at the end of 1993 (APA, 1994).

[215]Table VI.2, Appendix VI provides the displacement of the labour force according to regional classification.

[216]The Warsaw Seat includes the voivodships (counties) of Warsaw and the whole country, with respect to breeding stations. The Bydgoszcz seat incorporates the voivodships (counties) of Bydgoszcz, Torun and Wloclawek. The Elblag seat encompasses the voivodships (counties) of Elblag and Gdansk, whilst the Gorzow Wiekopolski seat includes the voivodships (counties) Gorzow and Zielona Gora. In Koszalin, the voivodships (counties) are Koszalin and Slupsk. The Lublin seat consists of the voivodships (counties) of Biala Podlaska, Chelm, Lublin, Radom, Siedlce and Zamosc, whilst in Lodz, it contains the voivodships (counties) of Lodz, Piotrkow, Plock, Sieradz and Skierniewice. In Olystyn, the voivodships (counties) include Ciechanow, Olsztyn and Ostroleka, and in Opole, they are Bielsko Biala, Czestochowa, Katowice, Krakow and Opole. The Pila seat includes the voivodship of Pila only, whilst the Poznan seat entails the voivodships (counties) of Kalisz, Konin, Leszno and Poznan. The Rzeszow seat governs the voivodships (counties) of Kielce, Krosno, Nowy Sacz, Przemysl, Rzeszow, Tarnobrzeg and Tarnow. In Suwalki, the seat includes the voivodships (counties) of Bialystok, Lomza and Suwalki, whilst the Szczecin seat covers the voivodship (county) of Szczecin alone. The Wroclaw seat includes the voivodships (counties) of Jelonia Gora, Legnica, Walbrzch and Wroclaw (APA, 1994).

5.4.2 Spatial divisions (see Map III.5, Appendix III)

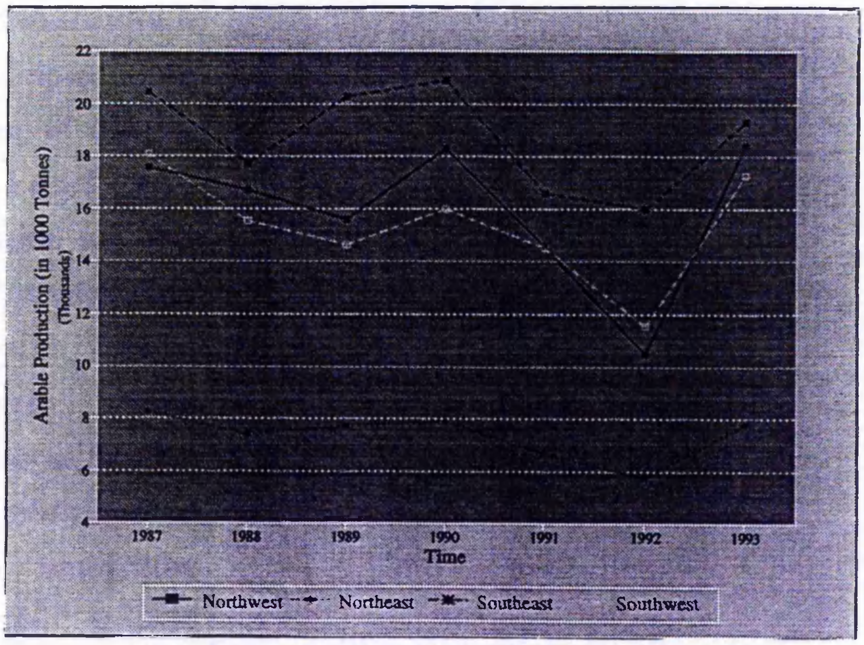

Figure 5.1: Private arable production during Polish Economic Transition, 1987-1993
[Source: GUS Publications, var. issues]

Spatial differentiation is based upon the evaluation of climatic, pedological, meterological and crop distribution information (Dawson, 1982), combined with information on the APA regional subdivisions of (former) state-owned land. The regional segregation is similar to that used by Boyd (1988), documented in section 4.2.1. Thus the region denoted as the 'Northwest' (NW) comprises of the voivodships (counties): Bydgoszcz, Elblag, Gdansk, Gorzow-Wielkopolski, Kalisz, Konin, Koszalin, Leszno, Poznan, Pila, Slupsk, Szezcin, Torun, Wloclawek and Zielona-Gora. The 'Northeast' (NE) encompasses the voivodships (counties): Bialystok, Ciechanow, Lomza, Olsztyn, Ostroleka, Suwalki and Warszawa. The region designated as the 'Southeast' (SE) consists of the voivodships (counties) of Biala Podlaska, Chelm, Kielce, Krosno, Lublin, Nowy Sacz, Przemysl, Radom, Rzeszow, Siedlce, Tarnobrzeg, Tarnow and Zamosc. Finally, the 'Southwest' (SW) includes Bielsko-Biala, Czestochowa, Jelonia Gora, Katowice, Krakow, Legnica, Lodz, Opole, Piotrkow Trybunalski, Plock, Sieradz, Skierniewice, Walbrzych and Wroclaw voivodships (counties).

Table 5.1: Selected indicators of Polish regional agricultural diversification (1993 figures, unless specified)

	Area of private land under cultivation (1000 hectares)	Area of (former) state land under cultivation (1000 hectares)	Average size of private farm	Size distribution of (former) state farms	Change in production 1988-1993 (%)
NW	2, 050.4 (27.9)	644.0 (55.9)	9.6	5, 766.6 1, 167.0	10.1^{p} -49.6^{s}
NE	988.9 (13.4)	129.6 (11.2)	8.7	4, 266.8 249.7	5.8^{p} -52.7^{s}
SE	2, 368.9 (32.2)	67.9 (5.9)	5.1	2, 988.0 247.0	8.7^{p} -54.6^{s}
SW	1, 951.4 (26.5)	310.1 (27.0)	6.6	3, 749.7 630.0	11.2^{p} -38.1^{s}

^{p} denotes private; ^{s} denotes (former) state

percentage in parentheses

[Source: GUS var. issues: and MAF. 1993]

A total of 2, 050.4[217] thousand privately owned cultivated hectares and 644.0 thousand (former) state-owned cultivated hectares[218] constitute the region specified as the northwest. Whilst this quarter has the highest concentration of (former) state-owned arable land under cultivation, it has also the largest state sector farm in the whole of Poland (5, 766.6[219] hectares). This is over 600 times the average size of a north western private farm (9.6 hectares) and is located in Poznan. The smallest (former) centrally-run farm is 1, 167.0[220] hectares, which is over 121 times the size of a private north western farm (9.6 hectares), and is situated in Wloclawek. Whilst north western (former) state production fell by 49.6 per cent, private production increased by 10.1 per cent over the period 1988-1993 (see Table 5.1 above). This region has some of the most productive and technologically advanced private and formally state-owned areas of Polish farming (Dawson, 1982; and Szemberg interview, 1994). With regards to the private sector, this is evident in terms

[217]At 1993 figures (see Table V.1, Appendix V).

[218]See Table V.2, Appendix V.

[219]There were no data on the average state farm size at GUS. Thanks to the 'Polish-American Extension Project', it was possible to obtain data for 1993 only.

[220]Op cit.

of higher proportions of foreign capital investment[221], land quality[222] (Classes III and IV); capital intensity[223]; output per worker[224]; fertiliser application[225] and the largest-sized private farms.[226] As for the (former) state sector, despite the general decline in state-orientated factor resources and the withdrawal of state subsidies, the state sector of the northwest is ranked second highest in terms of output per cultivated hectare[227]; output per tractor[228]; production per worker[229] and fertiliser usage[230] of all (former) centrally-planned regions. However, an above average level of unemployment[231] is now characteristic of this quarter, partly due to (former) state sector redundancies[232] (confirming Hypothesis 1, section 1.5).

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[221]The spatial distribution of investment generally follows that of land ownership. The highest levels of investment have been found both in the large cities, and also in the north and west, where the proportion of land in (former) state farms was the greatest (Dawson, 1982; and Szemberg interview, 1994; section 7.2.3 provides further documentation).

[222]Some of the best soils lie in the lower Vistula valley in the north of the country, and around Szczecin in the far northwest (Dawson, 1982; refer to section 7.2.1).

[223]There were approximately 2.46 agriculturally active private persons per tractor in this region in 1993. Corresponding figures for the northeast, southeast and southwest were: 3.11, 4.96 and 2.90 respectively (summarised in Table V.1, Appendix V).

[224]At 1993 figures, approximately 25.39 tonnes were produced per worker against 16.65 in the northeast, 12.39 in the southeast and 20.62 in the southwest. However, it is acknowledged that labour productivity is correlated with capital intensity (see Table 1, Appendix V).

[225]At 1993 figures, there were 260.4 average kilograms of fertilisers applied to one hectare of land, in contrast with 176.8, 133.4 and 152.6 average kilograms for the northeast, southeast and southwest (presented in Table V.1, Appendix V).

[226]The average size of a private farm in this region is 9.6 hectares, in contrast with 8.7, 5.1 and 6.6 hectares in the areas deemed as the northeast, southeast and southwest (GUS, 1989c, 1990d, 1991c, 1992c, 1993d and 1994).

[227]At 1993 figures, 4.43 arable tonnes were produced per cultivated hectare against 3.19, 4.19 and 5.41 in the northeast, southeast, and south western regions respectively (Table V.2, Appendix V provides more details).

[228]At 1993 figures, 1 tractor produced 55.27 tonnes of arable produce compared with 30.67, 19.61 and 60.11 tonnes in the northeast, southeast and south western regions respectively (refer to Table V.2, Appendix V).

[229]At 1993 figures, one worker produced approximately 29.4 tonnes in comparison with 15.4, 12.5 and 32.6 tonnes in the northeast, southeast and southwest respectively (see Table V.2, Appendix V).

[230]At 1993 figures, an average of 212.1 kilograms of fertiliser were applied per cultivated hectare in the production process, against 170.7, 92.5 and 244.5 in the northeast, southeast and south western regions (presented in Table V.2, Appendix V).

[231]Ranging from 11.7 to 34 per cent (Szemberg interview, 1994; Table VI.2, Appendix VI provides further documentation).

[232]Szemberg interview, 1994; and Dawson, 1982; see Figures 5.1 and 5.2; sections 1.4.2.1, 5.5.4.1, 6.5 and 7.5.3; and Table VI.2, Appendix VI).

The region representing the Northeast has the smallest area of cultivated arable land: the privately-owned sector totals only 988.9[233] thousand hectares and the (former) state-owned land totals only 129.6 thousand hectares.[234] The largest (former) north eastern state operated farm is 4, 266.8[235] hectares, which is equivalent to 500 times the size of an average family farm (8.7 hectares[236]) and is located in Suwalki. In contrast, the smallest is 249.7[237] hectares[238] (28 times the size of an average family farm) and is stationed in Ostroleka. Whilst north eastern (former) state-sector arable production had the second largest decline of all state sectors (52.7 per cent), private output increased by 5.8 per cent during 1988-1993 (refer to Table 5.1 above).

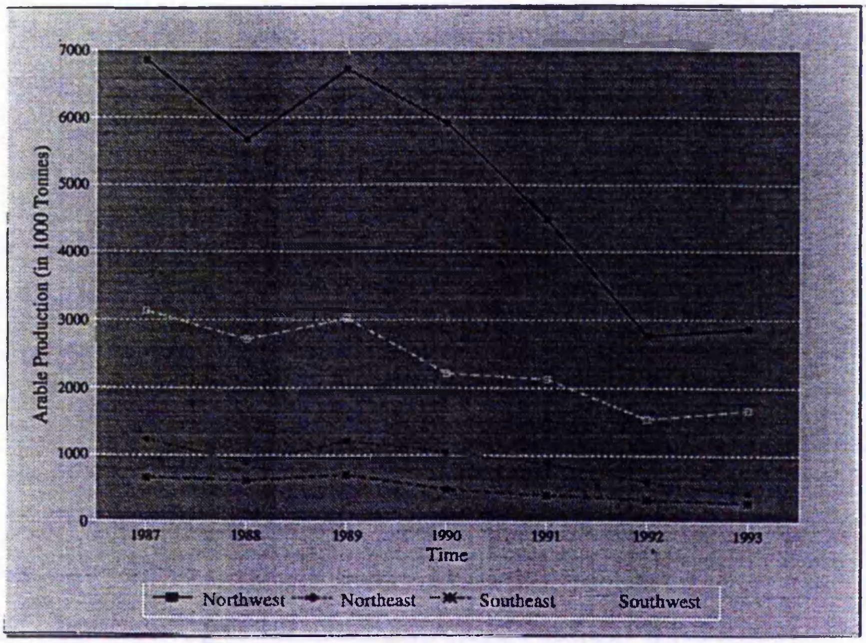

Figure 5.2: (Former) state arable production during Polish Economic Transition, 1987-1993
[Source: GUS Publications, var. issues]

The private sector of the northeast produced the lowest level of arable output per

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[233]At 1993 figures (presented in Table V.1, Appendix V).

[234]Refer to Table V.2, Appendix V.

[235]There were no data on the average state farm size at GUS. Thanks to the 'Polish-American Extension Project', it was possible to obtain data for 1993 only.

[236]The second largest of private farms of all four regions.

[237]There were no data on the average state farm size at GUS. Thanks to the Polish-American Extension Project, it was possible to obtain data for 1993 only.

[238]Op cit.

cultivated hectare[239] and per tractor[240] of all four quarters in 1993. This region had the second highest average fertiliser application per cultivated hectare in 1993[241], despite the overall decline in the use of fertilisers across the Polish agricultural sector. However, poor land quality (Classes V and VI)[242], a high labour intensive[243] production process, and a low rate of investment[244] are all contributors to the decline in the level of north eastern private production. Production levels in the (former) state-operated sector fell by 52.7 per cent which is the second largest decline across Poland. This is attributed to the second largest fall in capital inventories (-40.0 per cent), average fertiliser usage per cultivate hectare (-62.2 per cent) and cultivated arable land (-46.9 per cent) of all state sectors during this period. As such, output per (former) state cultivated hectare was the lowest of all four regions in 1993[245] (depicted in Figures 5.1 and 5.2 above, Table V.2, Appendix V; and further analyses in sections 6.5 and 7.3.3).

The agricultural structure of the region designated as the southeast is typified by small[246], family-owned farmsteads, and as such the proportion of private land sown heavily outweighs that of the (former) state sector. Whilst this region has the largest area of privately-owned cultivated arable land in the whole of Poland (2, 368.9[247] thousand hectares), it also contains the smallest area devoted to (former) state-managed farming, an area of only 67.9 thousand hectares.[248] The

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[239]7.87 arable tonnes were produced per cultivated hectare, in contrast with 8.98, 8.14 and 8.84 for the northwest, southeast and south western regions (presented in Table V.1, Appendix V).

[240]51.81 arable tonnes, compared with 62.36, 61.42 and 59.71 arable tonnes for the northwest, southeast and south western regions (refer to Table V.1, Appendix V).

[241]176.8 average kilograms against 260.4, 133.4 and 152.6 average kilograms per cultivated hectare for the northwest, southeast and south western regions. This translates as a 32.6 per cent fall during 1988-1993 (see Table V.1, Appendix V).

[242]The poorest soils are located in the centre and northeast of Poland (Dawson, 1982; and Szemberg interview, 1994).

[243]At 1993 figures, there were 3.11 private workers to every tractor, in contrast with 2.46, 4.96 and 2.90 in the northwest, southeast and south western regions (presented in Table V.1, Appendix V).

[244]Investment has been historically low in the central and eastern regions (Dawson, 1982; and Szemberg, 1992c, further documentation in sections 6.5, 7.3.3 and 7.4.3).

[245]The north eastern (former) state sector produced 3.19 tonnes per cultivated hectare, in contrast with 4.43, 4.19 and 5.41 tonnes in the northwest, southeast and south western (former) state regions (Table V.2, Appendix V).

[246]Averaging less than 2 hectares in some voivodships (counties) (Szemberg interview, 1994).

[247]At 1993 figures (refer to Table V.1, Appendix V).

[248]At 1993 figures (depicted in Table V.2, Appendix V).

size of an average private farm in this area during the six year period is 5.1 hectares which is the smallest of all private sector farms, and almost 586 times smaller than the largest (former) state farm. Whilst, the largest south eastern (former) state-managed farm is 2, 988[249] hectares in size and is located in Kielce, the smallest is 247[250] hectares and is situated in Radom. Private sector arable production in 1993 was 8.7 per cent higher than its 1988 figure, but (former) state sector arable output declined by 54.6 per cent over the same period (see Table 5.1 above). This is in direct response to the largest fall in the area of cultivated land[251], capital inventories[252] and fertiliser application.[253]

Other south eastern characteristics include poor land quality[254], high labour density[255]; low labour mobility; labour intensive production process[256] and an historically older rural workforce which may be the reason for the lowest level of output produced per worker, during 1988-1993 of all four private sectors[257] (Dawson, 1982 and Szemberg, 1992d). As for privately-owned capital inventories, this region had the lowest level of fertiliser usage[258] and the lowest number of

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[249]There were no data on the average state farm size at GUS. Thanks to the 'Polish-American Extension Project', it was possible to obtain data for 1993 only.

[250]Op cit.

[251]A decline of 53.0 per cent (presented in Table V.2, Appendix V).

[252]At 1993 figures, there were 14.5 thousand operative tractors in the south eastern (former) state sector in contrast with 51.6, 13.5 and 27.9 for the northwest, northeast and south western regions. This is equivalent to a 42.7 per cent decline since 1987 (Table V.2, Appendix V provides further analysis).

[253]Fertiliser application fell by 87.1 per cent between 1988 and 1993 in this region (depicted in Table V.2, Appendix V).

[254]Especially in the Carpathians in the south (Dawson, 1982).

[255]In 1993, there were 1.52 private cultivated hectares per worker in the southeast, compared with 2.83, 2.11 and 2.33 hectares in the northwest, southeast and southwest (further details in Table V.1, Appendix V).

[256]At 1993 figures, there were 4.96 private agricultural workers per tractor in the southeast, compared with 2.46, 3.11 and 2.90 in the northwest, northeast and southwest (refer to Table V.1, Appendix V).

[257]At 1993 figures, 12.39 arable tonnes were produced by each private sector worker, in comparison with 25.39, 16.65 and 20.62 arable tonnes for the northwest, northeast, and southwest (Table 1, Appendix V provides additional information).

[258]At 1993 figures, 133.4 kilograms on average, were applied to one hectare of cultivated land in the southeast. The corresponding figures were 260.4, 176.8 and 152.6 kilograms for the northwest, northeast and southwest (presented in Table V.1, Appendix V).

tractors per cultivated hectare[259] in the whole of Poland during the period. It is likely that this is because the private farms in this quarter are still largely dependent upon the use of horses in agricultural production (Nowicki, 1992). Thus, whilst subsistence farming dominates the Polish southeast, the overriding concern is that the private farmers here show no indication of a willingness to change or improve their economic situation[260] (refer to section 6.5 and Chapter 7).

The region denoted as the southwest includes the voivodships (counties) which were specifically devoted to the production of heavy industry, including coal and mining (Katowice) and the textile and clothing industries (Lodz). However, agricultural characteristics associated with this region are quite similar to those found in the Northwest, in terms of a higher land quality (Classes III and IV), capital intensive[261] production process, a higher concentration of (former) state-run farms and a higher level of investment[262] (Dawson, 1982; and Szemberg, 1992c). In fact, 310.1 thousand sown hectares[263] were under (former) state control producing the second highest (former) state sector output level (1, 677.1 thousand tonnes)[264], with the highest output per hectare (5.41) and per tractor (60.11) ratios in 1993. Nevertheless, (former) state sector output was still 38.1 per cent lower in 1993 than in 1988 (2, 708.5 thousand tonnes) in direct response to a 35.3 per cent decline in state sector arable land and a 62.6 per cent decrease in the total amount of fertiliser used. In contrast, south western private output increased by 11.2 per cent, despite a 52.9 per cent drop in average kilograms of fertiliser applied per hectare over the period (see Table 5.1 above).

Privately-owned cultivated land stood at 1, 951.4[265] thousand hectares: the second largest

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[259]In 1993, there were 7.54 hectares of privately-owned sown land per tractor against 6.95, 6.58 and 6.75 hectares per tractor for the northwest, northeast and southwest (refer to Table V.1, Appendix V).

[260]Szemberg interview, 1994; depicted in Figures 5.1 and 5.2 above, and Table V.1, Appendix V; detailed also in sections 6.5, 7.3.3 and 7.4.3.

[261]At 1993 figures, there were 2.90 private agricultural workers per tractor in comparison with 2.46, 3.11 and 4.96 persons for the northwest, northeast and south eastern regions (Table V.1, Appendix V provides further details).

[262]In 1993, there were 244.5 average kilograms of fertiliser used per hectare against 212.1, 170.7 and 92.5 average kilograms in the (former) state sectors of the northwest, northeast and southwest (documented in Table V.1, Appendix V).

[263]At 1993 figures (refer to Table V.2, Appendix V).

[264]Op cit.

[265]At 1993 figures (detailed in Table V.1, Appendix V).

area devoted to private arable production in Poland. This region was also characterised by the second highest producers per cultivated hectare (8.84) and per worker (20.62) in 1993. An average south western family farm is 6.6 hectares, 568 times smaller than the largest (former) state-run farm (3, 749.7[266] hectares) which is located in Opole and, the smallest is located in Skierniewice (630.0 hectares).[267] The quarter specified as the southwest also contains the localities of Wagry and Rzgow where primary data collection took place. 'Subsistence[268]' farming, family farms averaging 6 hectares with split plots, exemplifies the agricultural landscape here. Dual employment[269] is a financial necessity, and whilst the local factory provides the main source of household income, farming provides the subsidiary. More importantly, farm-level production is primarily consumed within the household: '..In 1992, we were able to sell potatoes and cabbage to bring in extra income, but everything else is for home consumption..' (Farmer interview, Rzgow, 1993).

In summary so far, it can be noted that the western regions of Poland seem to have responded more positively to market transition than either the southern or eastern quarters. This is largely due to better soils, higher capital stock (tractive force and fertilisers), and a capital intensive production process. Thus, despite general decline in arable production during 1990-1, the private sector of the western zones[270] showed the earliest signs of recovery in the 1993 output levels (see Table 5.1 above; and section 6.5). Finally, territorial land divisions and the historical movements in both labour and capital factors (documented in section 2.4) still remain significant contributors to the socio-economic development path of the rural landscape and the agricultural community.

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[266]There were no data on the average state farm size at GUS. Thanks to the 'Polish-American Extension Project', it was possible to obtain data for 1993 only.

[267]Op cit.

[268]As much as 40 per cent of the Polish private sector farming replicates 'subsistence agriculture' (Szemberg interview, 1994).

[269] '..Dual employment predominates here, workers in Lodz or Koluscie, the nearest town return to the farms in the evenings..' (Nowak interview, 1993).

'..Most farmers here have two jobs. The recession and Polish economic changes has meant people losing work from factories, (and) hence (there is) no money to invest..' (Terewszniski interview, 1993).

[270]During 1992-3, the area of north western cultivated land also rose by 7.6 per cent, the highest increase of all four private quarters (arable land increased by 3.1 per cent in the northeast, 3 per cent in the southwest and 1.4 per cent in the southeast (further details in Table V.1, Appendix V).

As a result, regionally distinctive levels of agricultural production exist.

The subsequent part (section 5.5) outlines the specification of the five conventional, independent variables (output, land, capital, fertiliser and labour) chosen for this particular model of Polish arable production. Each section divides into two: descriptions of the data used; together with an analysis of the recent trends in factor resources.

5.5 Variable specifications

5.5.1 Arable production, Output

The dependent variable, arable production is the aggregate of the four main crops (wheat, rye, barley, oats[271]) plus rapeseed, turnip, potatoes[272] and sugar. The final figure is converted into 1000 tonne units[273], from deci-ton measures, prior to regression.

Agricultural output is measured annually by GUS at the end of November of each year or at the end of the proceeding February and, is documented in both physical units (deci-ton weight) and in value terms (zlotys). In Poland most crops are planted in September, but certain crops, such as potatoes and barley are planted in the Spring. Harvesting occurs around July or August (Gemma, 1989). For this particular production model, statistics were extracted from the secondary sources at each year end (November). This model of arable output spans the years 1988-1993: the embryonic years in economic transition. Post 1993 data were excluded from the analysis for two reasons. First, only a certain number of specific agricultural products were documented in quarterly publications, making the aggregate data set on 'output' incomplete. Second, the statistical format changed dramatically in 1994, as the 'private' and (former) 'state' sectors of farming were no longer treated as separate entities, but as a whole. Thus, not only was 'output' aggregated into one single value, but the 'inputs' were evaluated in the exact same way.

The 'output' measure for Polish arable production includes both food for general consumption (a final good) and industrial use (an intermediate good).[274] This methodology was chosen principally because accurate and complete price indices across all six years, in all crops and

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[271]The data on cross breeds and mixes (such as winter wheat and wheat-rye) were omitted from the analysis.

[272]There is no indication of the types of potatoes planted.

[273]Data were extracted from GUS, 1987b, 1988b, 1989b, 1990c, 1991b, 1992b and 1993c.

[274]It was impossible to distinguish between the output levels of 'final' and 'intermediate' products.

all 'inputs', for each voivodship (county) were unobtainable. Therefore, it was impossible to deflate the 'value' data for price distortions and to estimate the real change in levels of production. Measuring 'output' in physical units are methods adopted by Zellner and Richard (1973); Florkowski, Hill and Zareba (1988); Yao (1993); and Battese, Malik and Gill (1996) (see sections 4.2.2 and 4.4.1). Finally, GUS provides no information on the spatial diversification in the quality of Polish agricultural production.

5.5.1.1 Arable production in Polish farming, 1987-1993

The results provided in Table 5.2 and Figure 5.3 below, indicate that during 1987-93, the privately-owned farms produced over 87 per cent[275] of the selected arable crops, whilst the (former) state-run farms generated less than 13 per cent.[276] Approximately 89 per cent[277] of the agricultural labour force worked in the private sector, whilst state sector employment accounted for approximately 10 per cent.[278] 82 per cent[279] of the total area of land sown belonged to private farmers, and 18 per cent[280] to the (former) centrally-planned farming sector.

[275] Average per annum.

[276] Op cit.

[277] Op cit.

[278] Op cit.

[279] Op cit.

[280] Op cit.

Table 5.2: Arable Production in Polish Farming, 1987-1993
(wheat, rye, barley, oats, potatoes, sugar beet and rapeseed)

Year	Private Output (1000 Tonnes)	Productivity (1987=100)	Annual change (%)	(Former) State Output (1000 Tonnes)	Productivity (1987=100)	Annual change (%)
1987	64,246.4	100		11,851.1	100	
1988	57,343.5	89	-10.4	9864.1	83	-16.8
1989	58,127.5	90	2.8	11,653.6	98	18.1
1990	62,939.5	98	6.3	9,623.3	81	-17.4
1991	52,359.5	81	-16.8	7,860.6	66	-18.3
1992	43,699.7	68	-16.5	5,200.7	44	-33.8
1993	62,724.5	98	43.5	5,227.3	44	5.1
Annual Average Yield	57,534.7			8,754.4		

[Source: GUS Publications, 1987b, 1988b, 1989b, 1990c, 1991b, 1992b and 1993c].

Harvest yields generated by the private sector were cyclical during the period. Between 1987-8, arable production fell by 6, 661.7 thousand tonnes (-10.4 per cent), but increased by 1, 603.8 thousand tonnes (2.8 per cent) in the proceeding year. Whilst the crop level rose again by 3, 751.0 thousand tonnes between 1989-90 (6.3 per cent), during 1990-2, it declined by 10, 580 (-16.8 per cent) and 8, 659.8 (-16.5 per cent) thousand tonnes consecutively, with the lowest level of production over the six year range in 1992 (43, 699.7 thousand tonnes). Arable crops in 1992 were only 68.0 per cent of their 1987 level, and 76.0 per cent of the annual average value over the seven year period. However, by 1993, private production had recovered by 19, 024.8 thousand tonnes (62, 724.5 thousand tonnes) which is equivalent to a 43.5 per cent rise on the previous year. Overall, the net effect between 1987-93 was a decline of 1, 521.9 thousand tonnes (-2.45 per cent) in national private arable crop production, which exceeds the annual average level over the whole period by 9.0 per cent. The private sector arable productivity index reflects the decline in arable output with the lowest estimate in 1992 (presented in Table 5.2 above).

The sharp fall in plant production in 1992 was precipitated by both the particularly harsh economic climate during 1990 and 1991 and the long-lasting dry weather[281 and 282] and outlay limitations (GUS, 1993b). In fact, 'difficult income conditions led to a naturalization of agricultural production and a decline in its intensity.' (GUS, 1993b: 38). The private farmers were compelled to reduce their productive capacity, leading to an increase in the consumption of their own production materials from 28 per cent in 1990-1991 to 35 per cent in 1992 (GUS, 1993b: 38). This was characterised, for example, by a national fall in the consumption of chemical and lime fertilisers (-25.6 per cent) (refer to section 5.5.3.2 and Table V.1, Appendix V); the substitution of manufactured inputs with home-produced inputs, where livestock was bred; stabilisation of tractive force and a decline in other capital inventories (see section 5.5.3); depletion of livestock resources: the slaughter of livestock was initiated at an earlier stage in their life cycle (Reed interview, 1994) and a fall in the sale of commercial feed supply (described in section 2.5). Unfavourable weather conditions, further decline in yield-stimulating means as well as a lower area of private land sown between 1990-2 (-2.4 per cent) compelled the drop of private plant production further (see section 5.5.2.1).

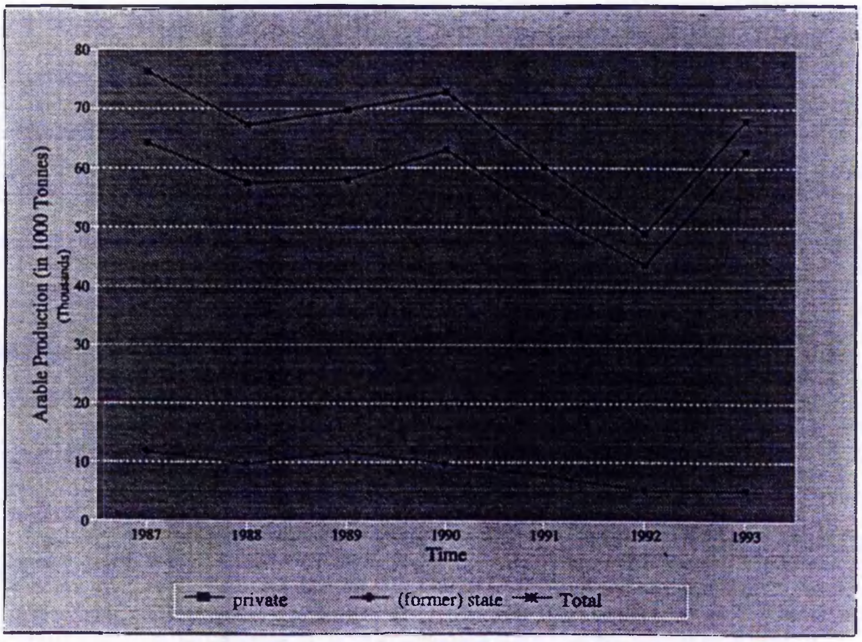

Figure 5.3: Arable production during Polish Economic Transition, 1987-1993 [Source: GUS Publications, var. issues]

Between 1992-3, however, the private sector began to show some positive signs of recovery and arable production increased by 19, 024.8 thousand tonnes (43.6 per cent) to a value

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281 '..1992 was a bad year for farmers due to dry weather, which means that wheat production was down 40 per cent on average..' (Farmer interview, Rzgow, 1993).

282 Average rainfall in 1992 was 539.83 mm per voivodship (county), in contrast with an average of 553.46 mm per voivodship (county) during 1990-93 (GUS, 1990c, 1991d, 1992c, 1992f, 1993d and 1994).

of 62, 724.5 thousand tonnes. A marginal decline in inflation[283] during 1993 and the rise in farmers real income led to a national increase in the consumption of fertiliser between 1992-3 of 8.1 per cent (see section 5.5.3.2). In addition, reforms of social security in 1990 and the extension of entitlements and benefits of the retirement-pension scheme have to some extent alleviated the plight of private farmers. Government spending on social measures for farmers increased dramatically-to more than two-thirds of total budgetary expenditure on agro-food policies in 1991-1993 (Portugal, 1995; refer to section 7.5.3). Finally, an improved trade balance and an increase in the GDP growth rate (3.8 per cent in 1993) are all positive indications that Polish economic stabilisation is gradually being felt within the agricultural sector.

(Former) state sector arable crop production showed a general downward trend over the period. The (former) state-run Polish farms produced on average 8, 754.4 thousand tonnes of arable crops per annum during 1987-1993. Whilst, harvest yields in 1987 stood at 11, 851.10 thousand arable tonnes, they fell to 9, 864.10 thousand tonnes in 1988 (-16.8 per cent), before recovering in 1989 to 11, 653.60 thousand tonnes (18.1 per cent). However from 1989 until 1992, arable crop levels declined during the three consecutive years, by 2, 030.3 thousand tonnes (-17.4 per cent), 1, 762.7 thousand tonnes (-18.3 per cent) and 2, 659.9 thousand tonnes (-33.8 per cent). By 1993, (former) state sector arable production had marginally recovered to 5, 227.3 thousand tonnes, which is a 5.1 per cent increase on the 1992 level, but represents only 44.1 per cent of the 1987 figure. The (former) state sector productivity index shows the depression in (former) state harvest yields (presented in Table 5.2, above).

(Former) state enterprises are unable to adjust to the market economy on their own. The decline in crop yields was largely due to the withdrawal of government subsidies and a guarantee in the sale of produce, customary of pre-1989 years. The economic reforms associated with the post-1989 period have manifested themselves in the 1991 and 1992 end-of-year bank balances, where state sector farming had lost 6.5 trillion zloty and 6 trillion zloty in each year (refer to 2.5.3 and 7.2.3). The mounting debts necessitated a further cut in production to avoid the risk of facing bankruptcy proceedings (APA, 1994). In many cases, the state farms were indebted to both banks, district and State budgets and trade partners. In order to maintain employment, there was no elimination of unprofitable production, or restructuring of the workforce and the expenditures on housing estates as well as social services constituted a significant part of the overall enterprise

[283]The inflation rate fell from 43.0 per cent in 1992 to 36.9 per cent in 1993 (Poznanski, 1995).

costs.[284] Output decline was inextricably associated with the fall in capital inventories, including tractive force (-39.9 per cent nationally) (see section 5.5.3.1), a substantial reduction in fertilisers and liming (-74.4 per cent nationally), a decrease in the amount of qualified seeds and plant protection; and land set-aside for non-agricultural purposes (detailed in 5.5.2.1 and 7.4.3). Unprofitable plant production on weak or difficult soil provoked the fallowing of larger and larger areas of state land. The reduction of yield-support chemical means and agrotechnical works together with unfavourable weather conditions resulted in the largest decline in arable (former) state production between 1991-2 (-33.8 per cent).

In 1992 the APA took over areas of land which was becoming increasingly neglected and land which had partially or completely ceased livestock production. In real terms, land which passed into the Agency between 1992 and 1993 totalled 1, 867.8 thousand hectares, equivalent to 26 per cent of the total agricultural area in productive use under state control in 1992. Of the 1, 867.8 thousand hectares, 168.3 thousand hectares (9 per cent) were defined as 'fallow' or 'under no contract use'. In the second half of 1993, land which passed into the Agency defined as 'fallow' or 'no contract use' increased to 13 per cent (APA, 1994). Other government land management policies include afforestation, recreation and tourism (Wos and Borek interviews, 1993/4; and APA, 1994; see also section 7.2.3, and Table VI.1, Appendix VI).

5.5.2 Land

This explanatory variable is defined as the total area of cultivated land under the selected crops. The data were presented in hectares initially, then aggregated, and converted into 1000 hectare units prior to regression.[285] This particular method has been used by Florkowski, Hill and Zareba (1988); Fleisher and Liu (1992); Yao (1993); and Johnson et al., (1994) (refer to sections 4.2.3 and 4.4.2). There were insufficient voivodship (county) level data on the area of arable land under irrigation or melioration for the complete time period to adjust for land quality, unlike studies by Ghosh (1971); Cornia (1984, 1985); and Kawagoe, Hayami and Ruttan (1985). Thus, it was

[284]By the end of 1993, debts of former state farms totalled 13.7 trillion zloty. 4, 015 billion zloty of debts were paid, including 2, 921 billion by the Treasury farms and 1, 094 billion by the Agency's Regional Branches (APA, 1994).

[285]Data were extracted from GUS, 1988b, 1988d, 1989e, 1990e, 1991e, 1992g and 1993f.

assumed that land quality reflected harvest yields.[286]

5.5.2.1 Cultivated land in Polish Farming, 1988-1993

Whilst 74.5 per cent of the total area of Polish cultivated land was classified as privately owned in 1988, by 1993, this figure had risen to 86.5 per cent (see Table 5.3 below and Figure 5.4). Thus, private land sown increased by 1, 642.6 thousand hectares (28.7 per cent) and (former) state land sown fell by 801.2 thousand hectares (-41.0 per cent) overall. However, this substantial expansion in the area of private land sown occurred between 1988-1989 (28.6 per cent), prior to economic transformation. During 1989-1992, the changes were negligible: three consecutive falls of 1.1, 1.4 and 1.0 per cent. In

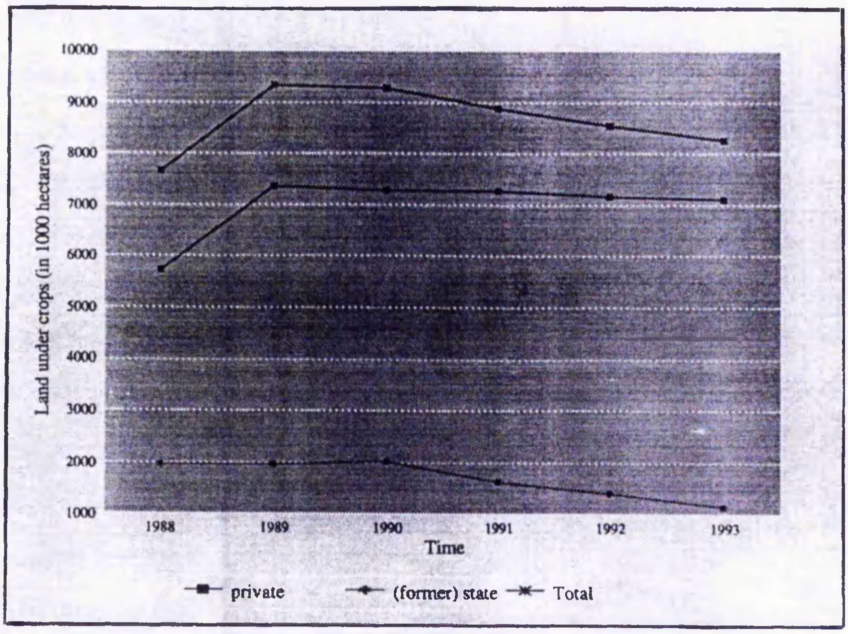

Figure 5.4: Cultivated land during Polish Economic Transition, 1988-1993
[Source: GUS Publications, var. issues]

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[286]As a quality-adjusted land variable yielded comparable land elasticity estimates at the intermediate stages of regression, the raw data were used in the final analysis (see Chapter 6). Land quality adjustment was carried out in the following way. Data relating to the land variable were adjusted to reflect the regional variation of the soil. This was performed by calculating the ratios of the regional land productivities against the national land productivity in the base-year (1988). The national private arable yield per cultivate hectare was 10.030 tonnes in 1988. The corresponding land productivities of the regions designated as the northwest, northeast, southeast and southwest were 10.39, 9.81, 9.60 and 10.28 tonnes. The ratio of private production in the northwest against the national average=10.39/10.030=1.0359. Therefore, each observation measuring cultivated land in the northwest is multiplied by 1.0359, reflecting the higher quality soils in the western areas of Poland. However, the ratio of private harvest yields in the northeast against the national average=9.81/10.030=0.978. Therefore, each observation measuring north eastern arable land is multiplied by 0.978, reflecting the poorer classification of land in this region. The ratios for the land variables of the southeast and southwest are: 9.60/10.030=0.957 and 10.28/10.030=1.0249. A similar procedure was carried out on the (former) state sector regions and the ratios were 5.21/5.051=1.0314 for the northwest; 3.58/5.051=0.7087 for the northeast; 4.33/5.051=0.8572 for the southeast and 5.65/5.051=1.1185 for the southwest, prior to economic policy change. As it was assumed the quality of land did not alter dramatically during 1988-1993, the calculated ratios were taken to be constant across the period. This procedure was used also by Boyd, 1988, 1991; detailed in 4.2.3).

fact, 1992 was also the year when private land productivity was also at its lowest[287] throughout the whole period (see Table 5.3). This may be partly attributed to the fact that although food demand had fallen significantly in 1990, the supply response was not fully felt until the subsequent years, 1991-2 (refer to section 6.5). However, it may also be because this arable production model measures a number of specific crops and omits production data on fruits and vegetables. Private farmers may have diversified their crop portfolios, marginally transferring arable land into fruit and vegetable production, as was the case in Wagry: '..wheat is the main product in this region, but we (Agricultural Service Centre) are trying to improve the production of fruit and vegetables. In fact, apples and strawberries are becoming increasing popular and there is an institute for apple growing..' (Nowak interview, 1994). Other changes in this region include the use of goats, for the production of goat's cheese and milk[288] (Nowak interview, 1994). Finally, despite the national rise in private land sown (3.7 per cent) and harvest yields (43.6 per cent) in 1993, agriculture in the regions remained '..alarming.. plot consolidation is particularly slow..' (Nowak interview, 1994). '..Increasing farm size will lead to higher levels of unemployment in the countryside and the towns. People love their land. It is almost impossible to change this degree of interest-it simply won't shift..' (Choynowoki interview, 1993).

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[287]However, it was also a particularly dry summer.

[288]However, a small cheese factory was shut down by the 'Health and Safety Regulations' because there was a pigeon house nearby (Nowak interview, Wagry, 1994).

Table 5.3: Cultivated land under selected crops in Polish Farming, 1987-1993

Year	Private (1000 hectares)	Land Productivity[a] (1988=100)	Annual change (%)	(Former) State (1000 Hectares)	Land Productivity[a] (1988=100)	Annual change (%)
1988	5,717.0	100		1,952.8	100	
1989	7,350.4	79	28.6	1,957.6	118	0.2
1990	7,266.1	86	-1.1	2,013.9	95	2.9
1991	7,266.1	73	-1.4	1,609.9	97	-20.1
1992	7,164.3	61	-1.0	1,386.1	74	-13.9
1993	7,094.9	85	3.7	1,151.6	90	-16.9
Annual Average Acreage	5,765.45			1,678.65		

[a]calculations based upon output per arable hectare

[Source: GUS Publications, 1988b, 1988d, 1989e, 1990e, 1991e, 1992g and 1993f].

Cultivated land in the (former) centrally planned sector steadily rose between 1988-1990 by 4.8 thousand hectares (0.25 per cent) and 56.3 thousand hectares (2.9 per cent). However, from 1990-93, it declined annually by 20.1, 13.9 and 16.9 per cent to an area of 1, 151.6 thousand hectares in total. Therefore, the largest fall occurred in 1990, 18 months after food prices had been liberalised and a year after the economic stabilisation programme had begun. The delayed response is likely to be owing to the institutional framework of former socialised farms (see section 6.5). Ownership transformation includes the sale, rent and laying fallow of state farm land.[289] Finally, (former) state land productivity reflects also the decline in (former) socialised arable output as the area of cultivated land was withdrawn from production.[290]

5.5.3 Capital: Tractors and Fertilisers

The 'inputs' specified as capital services divide into two distinct categories: tractors and fertiliser application. 'Tractive force, in 1000 pieces' is measured as the number of tractors in operation at

[289]APA, 1994; detailed in sections 2.5.3 and 7.2.3; see Table VI.1, Appendix VI.

[290]The (former) state land productivities suggest the performance of the state sector fared better than the private sector during economic transformation. Perhaps this is due to the location of (former) socialised farming. Analysis of individual productivity indices, however, is only a partial evaluation of the total change in factors of production (Wong, 1986).

year-end (November)[291] of the previous time period (1987-1992). This is because the changes in tractor stocks in the current year takes place largely after the completion of field operations.[292 and 293] Other authors who have used a similar approach include Bhattacharjee (1955); Yorgason and Spears (1971); Yotopoulos (1968); and Florkowski, Hill and Zareba (1988) (documented in sections 4.2.4 and 4.4.3). Tractors were chosen as the sole measure of agricultural mechanisation simply because there were no private and (former) state voivodship (county) level data available for the other farming machines (for example, milking machines, tillage sets, sowers, cutters, potato and sugar-beet combines, combine harvesters, corn harvesting machines, specialised trailers and motor tools). GUS provides no additional information relating to quality[294] or types of tractors[295], rates of capital utilisation, rented capital, or the average level of horsepower.[296] Voivodship (county) level data on horse inventories, by ownership were unobtainable for all seven years[297], so were also omitted from the production model. Despite the fact that half of all Polish private farms owned a tractor in 1992 (GUS, 1993b), the use of draught horses remains popular,

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[291]Data were extracted from GUS, 1987a, 1988c, 1989c, 1990d, 1991c, 1992c, 1993d and 1994.

[292]Private arable production was at its lowest in 1992, whilst the change in capital inventories was at its lowest in 1991 (refer to section 5.4.2.1 and Table V.1, Appendix V).

[293]In fact, the regressions tested both variables: capital at time, t and at time, t-1. The output elasticities were not significantly different (detailed in Chapter 6).

[294]As a quality-adjusted capital variable yielded similar capital elasticity estimates at the preliminary stages of regression, the raw data were used in the final analysis (see Chapter 6). There were two stages of capital quality adjustment. First, data on 'operative tractors, in 1000 pieces' were converted into horsepower equivalent. Second, the data were adjusted for the sectoral difference in capital quality using information relating to UK farming. The methodology was based upon a series of assumptions relating to Polish and UK fieldwork. An average UK tractor is 120 HP (Saxby, 1996). Empirical research carried out in Poland during 1988-1992 classified 34 per cent of Polish private farms as 'well-mechanised' (Szemberg, 1992c: 23). The first assumption is that this segment of private Polish farming owned tractors which were UK HP equivalent. The second supposition is that the remaining 66 per cent of farms possessed tractors which were 40 HP (common on <6 hectare farms). The third conjecture is that the relative proportion remained constant during 1988-1993 and neutral technical progress. Therefore, the parameter reflecting operational capital in the private sector= (number of tractors (1000's) x 0.33 x 120)+(number of tractors (1000's) x 0.66 x 140). The fourth hypothesis is that all (former) state-owned capital was UK horsepower equivalent, owing to heavy government subsidisation in the former communist era. Therefore, 'operational capital' in the (former) state sector regressions was defined as the number of tractors (1000's) x 120 HP. Other authors who have used a similar approach include Lau and Yotopoulos, 1968; Hayami and Ruttan, 1971, 1985; Everson and Kislev, 1975; Nguyen, 1979; Yamada and Ruttan, 1980; Mundlak and Hellinghausen, 1982; Antle, 1983; Kawagoe, Hayami and Ruttan, 1985; Wong, 1986; and Boyd, 1988, 1991; see sections 4.2.4 and 4.4.3; and Appendix VIII.

[295]Many Polish tractors are either second-hand or home-made (Kisiel interview, 1994; refer to section 7.3.3).

[296]May range from 35 HP to 250 HP, depending on the size of the tractor.

[297]Data collection on horses ceased at the end of 1990.

particularly in the farms of southern and eastern Poland[298] (Nowicki, 1992). However, the results of a survey carried out on a sample of 4, 385 farms during 1988-1992, indicated a significant decline from 42 to 31 horses per 100 farms, representing a fall from 26 to 16 per cent (Szemberg, 1992c).

The application of fertilisers is measured as the aggregate of chemical (nitrate, phosphate and potash (growth stimulants) and lime[299], in pure concentrate at year end[300 and 301], similar to the method used by Boyd (1988, 1991) (detailed in section 4.2.4 and Appendix VIII). However, GUS provides no additional details on either the quality, frequency of application, dispersion of fertilisers between crops or the ways it is sold. In this country, fertiliser is delivered to the farm in 100 kilogram bags and can be bought as a compound of nitrates, phosphate and potash, mixed with limestone and bulked to make up to 100 kg weights. The ratios of the pure ingredients depends upon the crops grown. For example, an average seasonal crop of barley (6 tonnes per hectare), requires 170 kgs of nitrate, 45 kgs of phosphate and 45 kgs of potash, but an average seasonal crop of sugar (40 tonnes per hectare), requires 100 kgs of nitrate, 50 kgs of phosphate and 190 kg of potash (Saxby, 1996). Thus, highly aggregated measures of both crop production and fertiliser application may distort the true effects of fertilisers on Polish harvest yields (described in section 4.4.1). Furthermore, there were no data available on the level of home produced or organic fertilisers used either on the farm, at voivodship (county) level or nationally. Since farming in Poland is mainly organic[302], fertiliser use is viewed as a proxy for advanced, chemical and biological agricultural technology rather than as a straightforward measure of fertiliser as an input. Finally, there are no data on pesticides, insecticides or herbicide application

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[298]Documented in section 4.2.4.

[299]This includes any of the certain calcium compounds, especially calcium hydroxide, spread as a dressing on-lime deficient land to reduce acidity.

[300]Data were extracted from GUS, 1989c, 1990d, 1991c, 1992c, 1993d and 1994.

[301]An alternative estimation used was 'Total consumption ='kilograms per cultivated hectare' x the area of arable land, converted into 1000 metric tonne units'. However, this lead to an increase in the risk of multicollinearity which would affect the reliability in the regression results (see Chapter 6).

[302] '..All organic fertilisers are used in agriculture. Too costly otherwise..' (Nowak interview, 1994).
'..All organic-very little is bought-too expensive..' (Wagry farmer, 1994).

at the voivodship (county) level, and as such, these independent variables were omitted[303] from the Polish model of arable production.

5.5.3.1 Operative Capital in Polish farming, 1987-1993

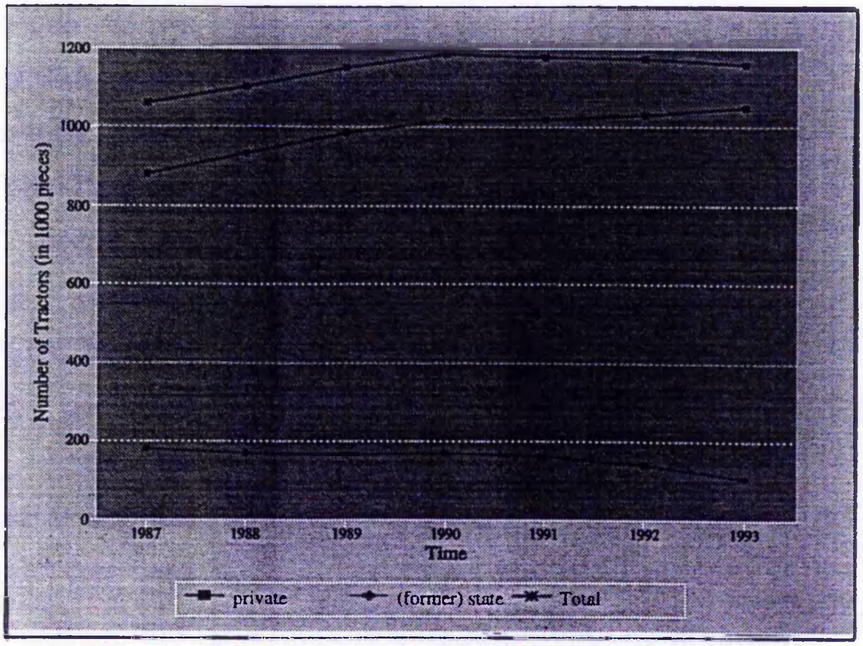

Figure 5.5: Operative Capital during Polish Economic Transition, 1987-1993 [Source: GUS Publications, var. issues].

In 1987, over 83 per cent of all Polish tractors were privately owned and less than 17 per cent operated within the (formally) centrally-planned sector. By 1993, over 90 per cent operated within the private sector and less than 10 per cent were classed as state owned. As the number of private tractors steadily increased during 1987-1993, (former) state sector capital inventories declined considerably (represented in Table 5.4 and Figure 5.5 below). Private farmers owned 880.0 thousand pieces in 1987, increasing to 931.9 in 1988 (5.9 per cent), and to 988.0 in 1989 (6.0 per cent). In 1990, there were 1, 016.4 thousand tractors (2.9 per cent) rising slightly to 1, 018.8 thousand by 1991 (2.4 per cent). A total of 1, 032.6 (1.4 per cent) and 1, 048.4 (1.5 per cent) thousand pieces operated within private agriculture in 1992 and 1993. During the whole period, private tractor inventories rose by 168.4 thousand (19.1 per cent) overall. Moreover, the 1993 level was 6.1 per cent above the average annual number of tractors (988 thousand) in operation over the period 1987-1993 (refer to section 7.3.3). Private capital productivity reflects the cyclical trend in private arable output during 1987-1993. In addition, it shows private capital productivity in 1993

[303]Omission of theoretically significant independent variables from the arable production model is likely to have resulted in specification errors (see Chapter 6).

remained below its 1988 level (see Table 5.4 below).[304]

(Former) state sector capital stood at 178.8 thousand pieces in 1987, but fell consecutively during 1988 and 1989 (-5.2 and -3.4 per cent respectively) to 169.5 and 163.8 thousand pieces respectively. Although the level recovered slightly in 1990 with a 2.6 per cent rise, by 1991, it had fallen again to 159.9 thousand (-4.9 per cent). From 1992-3, mechanisation levels within the (former) centrally-planned sector declined significantly by 13.0 and 23.0 per cent to a level of 107.5 thousand pieces. Whilst the 1993 level was 39.9 per cent lower than its 1987 level, it was also 69.2 per cent of the annual average during this period. This downward trend is primarily due to the privatisation of former socialist agricultural land and property in response to economic transition (detailed in sections 1.4.2.1, 2.5, 5.5.2.1, 6.5 and 7.3.3). Finally, (former) socialised capital productivity fell consistently after 1990 indicating the depletion of (former) state-managed capital and the coinciding fall in socialised arable production.

Table 5.4: Operative Capital in Polish Farming, 1987-1993

Year	Private Capital (1000 pieces)	Capital Productivity[a] (1987=100)	Annual change (%)	(Former) State Capital (1000 pieces)	Capital Productivity[a] (1987=100)	Annual change (%)
1987	880.0	100		178.8	100	
1988	931.9	84	5.9	169.5	88	-5.2
1989	988.0	81	6.0	163.8	107	-3.4
1990	1016.4	85	2.4	168.1	86	2.6
1991	1018.8	70	0.2	159.9	74	-4.9
1992	1032.6	58	1.4	139.6	56	-12.7
1993	1048.4	82	1.5	107.5	73	-23.0
Annual average	988.0			155.3		

[a]calculations based upon output per tractor

[Source: GUS Publications, 1987a, 1988c, 1989c, 1990d, 1991c, 1992c, 1993d and 1994].

[304]This is due to a combination of factors. First, capital substitution, especially in the more affluent farms situated in the northwest. Second, capital stabilisation (detailed in Chapters 2 and 7). Third, the quality of the privately-owned tractors is likely to have fallen during 1987-1993 as repair work became increasingly expensive, reducing capital utilisation of the existing capital stock (see also 3.5).

5.5.3.2 Fertiliser Usage in Polish farming, 1988-1993

Fertiliser use declined in both sectors of Polish farming during the embryonic years of economic reform. Whilst total fertiliser consumption by privately-owned family farms fell by 25.6 per cent, the corresponding state sector decline was 74.4 per cent during 1988-1993 (depicted in Figure 5.6 and Table 5.5, below). Despite a 43.7 per cent rise in private sector purchase of manure during 1988-89, from 1990 until 1992, manure consumption continued on a downward trend, falling in two consecutive years by 36.2 per cent and by 10.3 per cent. However, in 1993, it rose marginally by 8.1 per cent. Thus, private harvest yields and fertiliser use were both at their lowest levels in 1992. The principle reason were substantial price rises for agricultural inputs (refer to sections 2.5, 6.5 and 7.4.3). Moreover, the depletion in livestock resources is likely to have depressed the private sector home-produced fertilisers as well: '..small farms do not use chemical fertilisers, only organic, if there is livestock kept on the farm. The older farmers use only green fertilisers, for example, lupin; larger farms use chemical fertilisers..' (Farming Intermediary interview, Rzgow, 1993). As for the (former) socialised sector, the largest decline in fertiliser consumption occurred in 1991 and 1992, principally because of the withdrawal of subsidies, but also as cultivated land in the (former) state-managed farms was laid fallow or set-aside for non agricultural purposes (APA, 1994; see sections 2.5.3, 6.5 and 7.2.3; and Table VI.1, Appendix VI).

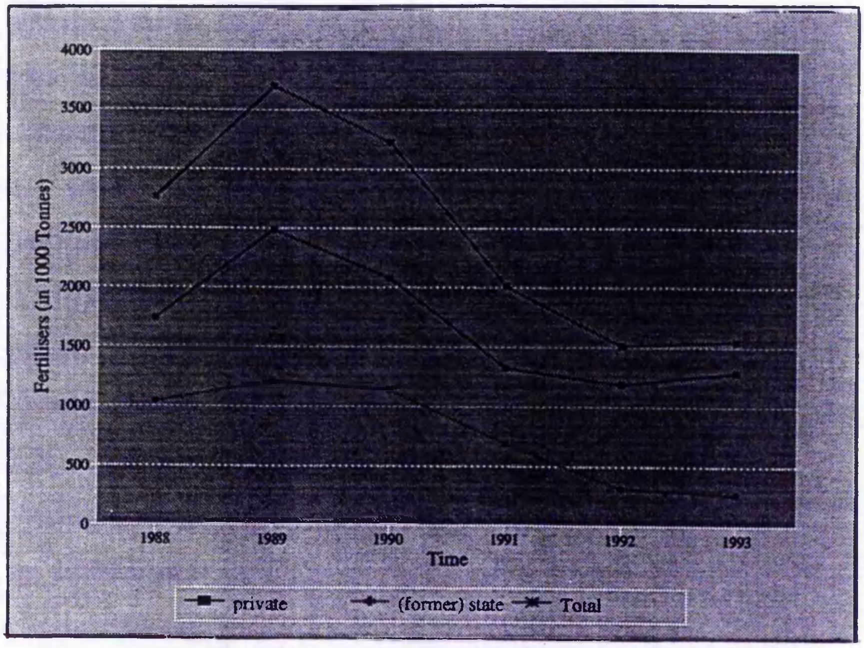

Figure 5.6: Fertiliser Usage during Polish Economic Transition, 1988-1993 [Source: GUS Publications, var. issues].

Table 5.5: Fertiliser Usage[a] in Polish Farming, 1988-1993

Year	Private Fertiliser (1000 tonnes)	Annual change (%)	(Former) state Fertiliser (1000 tonnes)	Annual change (%)
1988	1,729.4		1,032.2	
1989	2,485.0	43.7	1,209.4	17.2
1990	2,080.5	-16.3	1,142.4	5.5
1991	1,327.6	-36.2	689.2	-39.7
1992	1,190.8	-10.3	314.4	-54.4
1993	1,287.4	8.1	264.6	-15.8
Annual Average	1443.0		775.4	

[a] calculated using 'kgs. per hectare' x cultivated area/1000)

[Source: GUS Publications, 1989c, 1990d, 1991c, 1992c, 1993d and 1994].

5.5.4 Labour

Labour is defined as the 'number of workers in 1000s'[305] as used by Bhattacharjee (1955); Yorgason and Spears (1971); Zellner and Richard (1973); Zuberi (1990); and Fan (1991) (documented in section 4.4.4). This method was chosen above 'deflated wage' because of insufficient information regarding both private and state sector wage levels and relative price indices during this period. However, a complete set of labour data in stock number was also impossible to obtain, despite a succession of interviews with GUS delegates. For the private sector in 1988, data were estimated from the 'economically active population in agriculture' less the 'number of employees in the agricultural (former) 'state' sector', up to year-end (November). Labour data omission resulted in data intrapolation for the private sector (1990-1991) and data extrapolation for the (former) socialised sector (1990-1993) prior to regression[306]. GUS were unable to offer any explanations for missing values, only that it was owing to the 'chaos' caused

[305]Data were extracted from GUS, 1990b and 1992f.

[306]Data intrapolation and extrapolation were based purely on the trend over time (yearly estimates); probable variations in the cross-sections were omitted from the process. Data extrapolation and intrapolation for both sectors were based upon methodologies used in previous research on 'Regional Differences in Agricultural Productivity in Selected Areas of India (Easter, Abel and Norton, 1977). However, it is acknowledged that inaccuracy in the labour data set may have either underestimated or overestimated the factor share of labour in the production process.

by economic transformation.[307] Moreover, inadequate documentation resulted in being unable to fully account for the differentiation in the quality of labour.[308] Qualitative variables including: age[309]; sex; education or training; the percentage of family workers, seasonal work force and the proportion of workers in the arable or diary sectors at voivodship (county) level in the rural labour force were omitted from the analysis. To conclude, inherent flaws in the labour data set mean that the results obtained are only a proxy, or a rudimentary indication of the role of labour in the processes of Polish agricultural production.

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[307]Note that Poland is by no means an exception. Brock (1994) in his study of Agricultural Productivity in Volgograd Province (FSU) also refers to '..chaos in statistical administrations..' (Brock, 1994: 33).

[308]As the quality-adjusted labour variable did not significantly change the labour elasticity estimates in the regressions, the raw data were utilised in the final production model. Quality adjustment was carried out in two stages. First, data relating to the 'number of workers in 1000s' were converted into 'man-years', as used by Chowdbury, Nagadevara and Heady, (1975) and Cornia (1984, 1985) (see section 4.4.4). Second, a series of assumptions were formed to account for the differentiation of the agricultural work force using base-year information. The economically active rural population was divided into four segments: male and less than 60 years old; male and over 60 years old; female and less than 60 years old; and female and over 60 years old. In 1988, each group represented 40.6 per cent, 12.7 per cent, 33.5 per cent, and 13.2 per cent of the rural population respectively (GUS, 1992f: 17). The first assumption is that the size of each category remained constant during 1988-1993. The second conjecture is that 1 male worker, less than 60 years old=1 man-day. The third presumption is that 1 male worker, over 60 years old=0.5 man-day. The fourth argument is that 1 female worker, less than 60 years old=0.8 man-day and the fifth hypothesis is that 1 female worker, over 60 years old=0.4 man-day. Therefore, the labour data sets of both sectors = (number of workers x 0.406 x 365) + (number of workers x 0.127 x (0.5 x 365)) + (number of workers x 0.335 x (0.8 x 365)) + (number of workers x 0.132 x (0.4 x 365)). The weighting index was devised by the author, as earlier studies provided no information relating to labour productivity approximation. Finally, whilst labour productivity is a function of the intrinsic characteristics of a farmer (such as decision-making, management, education or risk aversion), it is also dependent upon a number of other factors including technology, working capital, land structure and agricultural location, worker or employer and size of farm (Ilbery, 1989).

[309]In Poland, 40 per cent of farmers are aged between 60-70 years old and 32 per cent are over 70 years old (Szemberg, 1992a).

5.5.4.1 Labour in Polish Farming, 1988-1993

The Polish rural work force declined by a total of 20.1 per cent between 1988-1993 (see Figure 5.7 and Table 5.6 below). Whilst, 41.8 per cent of this fall represents the relocation of former state sector labour resources (represented in Table VI.2, Appendix VI), 58.2 per cent of it relates to demographic change which began in the early 1970s (Szemberg, 1992d). Since 1988, the number of people living on farms fell by 5 per cent equating with the decline in the number of farms. In addition, the percentage of farms owned by younger people increased, whilst the share of ownership amongst the older generation fell across the whole of Poland and in all the different farm size groups. For example, more young men after completing military service, graduates and school-leavers were considering farming as a career (Szemberg, 1992d). However, en masse urban-rural migration outweighed rural-urban migration, in response to both the economic recession and the conditions of prevailing high unemployment, associated with economic stabilisation (Szemberg, 1992d). Of those who left farming, the service sector was the largest source of private-sector work, particularly in the rural areas where both general consumer services and agricultural services provided opportunities for employment (Szemberg, 1992d). As for the former employees of state-managed farms, many were either offered share ownership, pensions for retirement or made redundant (confirming Hypothesis 1, section 1.5; others set up their own private businesses (additional information in 6.5 and 7.5.3; and Table VI.2, Appendix VI). It is difficult to make reliable deductions from the labour productivities as they are based upon intrapolated and extrapolated labour data. However, they do suggest an overall increase in labour productivity in

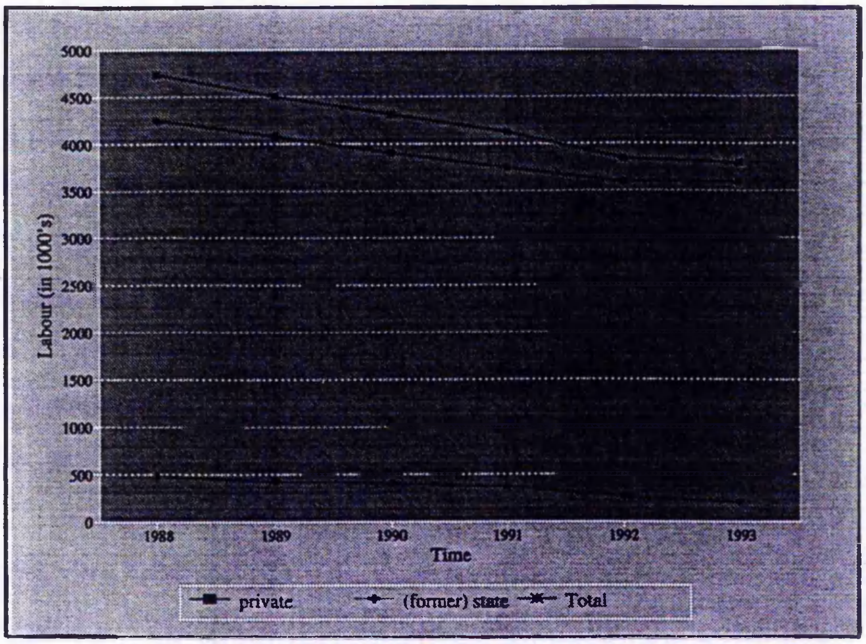

Figure 5.7: Rural Employment during Polish Economic Transition, 1988-1993 [Source: GUS Publications, var. issues].

both sectors during 1988-1993. This is due to the declining ratio between labour resources and arable production.

Table 5.6: Employment in Polish Farming, 1988-1993

Year	Private Employment (1000 persons)	Labour Productivity[a] (1988=100)	Annual change (%)	(Former) state Employment (1000 persons)	Labour Productivity[a] (1988=100)	Annual change (%)
1988	4,256.7	100		478.3	100	
1989	4,068.9	106	-4.4	420.3	134	-12.1
1990	3,905.1	120	-4.0	402.7	116	-4.2
1991	3,747.1	104	-4.1	371.3	103	-7.8
1992	3,583.1	91	-4.4	270.1	93	-27.3
1993	3,586.1	130	0.1	198.1	128	-26.7
Annual Average	3,857.8			356.8		

[a]calculations based upon output per person

[Source: GUS Publications, 1990b and 1992f].

In summary, whilst the first two parts of this chapter (sections 5.2 to 5.5) focused on the problems associated with Polish data sources and the variable specifications of this arable production model, the final part (section 5.6) discusses the significance of farm size as an independent variable and considers the use of weather variations as a nonconventional variable.

5.6 'Nonconventional' variables

5.6.1 Size

Different types of agricultural organisation play a central role in determining the pace of agricultural growth and development. This is because the relationships between such factors as farm size and tenure rights have profound effects on performance.[310]

Farm size and land productivity have formed the basis of economic debate within economic development literature since the 1950s. The publication of the results of the Indian farm management studies showed that there was an inverse relationship between farm size and land productivity. Subsequent empirical investigations carried out in many developing countries

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[310]'Performance' incorporates productivity growth, resource allocation, and technological advancement.

(LDCs) of Asia, Latin America, Tropical Africa and the Middle East have validated this association. This is noteworthy on two counts. First, the varying climatic and/or geographical characteristics of contrasting countries and second, the high land/labour ratios and the different agrarian structures associated with countries of Africa and the Middle East have had no significant affect on the aforementioned results (Cornia, 1985). The central theme in the literature is that small and large farms systematically face different sets of factor prices giving them different access to resources and different incentives to produce. Very generally, it could be said that the effective price of land and capital is usually higher for small farmers whereas the effective price of labour is lower (Cornia, 1985).

Between 1973 and 1979, a productivity analysis was performed on cross-sectional data on overall farm crop and yield accounting across 18 developing countries. The results showed that small farms are characterised by a more intensive use of land and resource inputs per hectare than large estates. As a result, land yields are significantly higher in small farms (Cornia, 1985). This complements the situation in Poland where the private sector, dominated by small farms, has had consistently higher land and labour productivities than the large farms in the socialised sector (Manteuffel, 1982; Simatupang, 1983; Florkowski, Hill and Zareba, 1988; and GUS, various issues; documented in section 2.4; see also Table V.1, Appendix V). According to Cornia, the yield-gap tends to level off between large and small farms when sufficient job opportunities in the non-agricultural sector become available (Cornia, 1985).

A more recent study by Fleisher and Liu (1992) investigated the effects on agricultural productivity levels through the consolidation of family plots in Chinese agriculture. As a result of the agricultural land reform policy, the average amount of land operated per household was 0.27 hectares (1.63 acres) and was generally segregated into a number of smaller plots which were situated in different regions. Plot consolidation would potentially increase total output, given total inputs in the following ways: reduced travel time between plots; more efficient irrigation with less start-up costs per unit of land, each time a plot is irrigated; more efficient control of pollination; more efficient control of pesticide use; improved location of crops with respect to sunlight (short crops less frequently shaded by tall crops) and more efficient use of farm machinery. In conclusion, Fleisher and Liu found that there was a vast number of unexploited opportunities of crop-specialisation and plot-size economies because of the limitations in the cultivation rights and secondly the farmer's risk aversion associated with the consolidation of plots in one locality because of the risk of weather, flooding, insects etc. (Fleisher and Liu, 1992).

Bachman and Christensen (1967) identified three specific, yet related links between farm size and alternative measures of efficiency. First, the relationship between farm size and static efficiency[311]; second, the effect of farm size on the development and adoption of technology, and hence the pace and scope of growth due to technological advancement; and third, farm size and farm level organisation, such as, the coordination of decision-making and the provision of incentives.

First, if land productivity (output per unit of land) is taken as a measure of static efficiency, previous studies have proved that farm size is inversely related to efficiency. This implies that small farms can be as least as efficient as the large farms, in developing countries, where the traditional methods of farming prevail (Yotopoulos and Nugent, 1976; and Berry and Cline, 1979). This is owing to the contrasting factor endowments of the large and small scale farms. Although both types (sizes) of farms are technically and economically efficient in their choice of input combinations, the fundamental difference lies with the varying ratios of land and labour. The small farms are those where land is scarce relative to labour and the large farms are where the opposite occurs; labour is scarce relative to land. The varying farm size distribution within the agricultural sectors of the developed and developing world, led to the evaluation of the 'bimodal'[312] and 'unimodal'[313] size distributions of holdings (Johnston and Kilby, 1975).

In terms of allocative efficiency[314], economic theory suggests that it would be more desirable for an even distribution of relatively small farms to dominate the agricultural landscape. This is primarily due to the fact that the utilisation of labour is especially low, relative to the other factors of production, and hence there is a larger employment generating capacity. Furthermore,

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[311] Static efficiency implies both technological and economic efficiency. The connection between farm size and efficiency necessitates the consideration of other issues, such as establishing the optimal farm-size distribution for allocative efficiency, (i.e. the ability to produce maximum output from a given resource base) given relative factor scarcities, and the related practical importance of economies of scale (further details in Appendix IV).

[312] The 'bimodal' size distribution of farms occurs when there is a small number of very large farms and a large number of very small and possibly fragmented farms (Boyd, 1988, 1991).

[313] The 'unimodal' size distribution of farms is one in which the bulk of farms are of intermediate size and a relatively small number are at both the small and large extremes.

[314] The relevance of the concept of efficiency (allocative efficiency in particular) has been questioned extensively in the literature (Rizzo, 1979; Pasour, 1981; and Colman and Young, 1993) principally in those cases where prices are distorted, and producers have imperfect knowledge and may pursue goals other than profit maximisation.

land productivity measures of developing economies have illustrated and supported this view (Boyd, 1988, 1991). However, the existence of large scale farms in both developed and developing countries, where land is abundant and labour is scarce, has necessitated the application and advancement of technology and mechanisation, which have, in turn precipitated increasing returns to scale. The adoption of newer techniques by the large and medium size farms towards increasing agricultural productivity, usually results in the eventual adoption of the technological methods by the smaller farms. Hence, when evaluating the relative contributions of the small and large farms, it is necessary to balance allocative efficiency with dynamic efficiency.[315] In essence, therefore, it would appear that the unimodal size distribution will, in general, produce a more efficient allocation of resources, since it utilises more labour without hampering the level of output and without the loss of economies of scale (section 6.5 provides further analysis).

The third criterion involves farm size and the role of technical institutions in coordinating decisions and providing incentives. The concept of 'induced institutional change' is associated with 'induced technological change'[316] (Hayami and Ruttan, 1971; Binswanger and Ruttan, 1978; and Ruttan, 1982). The larger farms, with a higher land: labour ratio, adapt to technological influences more rapidly than the smaller farms, to increase output. As such, the role of research and the transition from a 'resource-based sector to a science-based industry' (Ruttan, 1982: 3) is paramount for economic development.[317] Finally, both differences in organisational structure (such as ownership and control rights), and in farm size may create problems of coordination and incentives in larger farms (detailed in sections 1.3, 1.4.2.1 and 7.2.3).

In summary, the main issues presented include the effects of size distribution on the efficient allocation of resources; the level of productivity in both small and large farms and the role of technology and finally that the combination of the contrasting organisational structure and the various size of farms may cause dilemmas in coordinating decisions. Thus, whilst farm size

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[315]Dynamic efficiency is increasing the maximum output available from a given resource base, through technological change.

[316]This means that technological mechanisms are adapted to the factor scarcities associated with a particular environment. For example, different types of machinery are used on different sized farms or technological innovations are adopted more rapidly on the larger farms.

[317]Technological advances release the constraints on production imposed by the natural environment and human labour. Consequently, this requires the development of research institutions to improve the utilisation of the resources available. Throughout the world researchers consistently find the social rates of return to agricultural research to be among the highest of public investments (eg. Hayami and Ruttan, 1985).

directly affects the allocation of factor resources and dynamic efficiency, empirical research suggests average farm size has had an insignificant effect on levels of agricultural production and the smaller farms in the LDCs can be as productive as the larger estates (Cornia, 1985). Therefore, the inclusion of 'size' as an independent variable is deemed irrelevant, and to conclude data on the distribution of farm size across Poland were omitted from the econometric analysis[318] (documented in Chapter 6).

5.6.2 Weather

Weather variation is implicitly linked to annual harvest yields and as such, it is usually included within an arable production model.[319] In earlier studies, 'weather' has been represented as a dummy variable (Fleisher and Liu, 1992), a random error term (Boyd, 1988, 1991) and as an additional independent variable, such as the annual rainfall (Yao, 1993). To this end, data on annual rainfall (mm), at year-end (November) were chosen for this model of arable production. The average annual rainfall during 1986-1990 was used for the year 1988 and the yearly average rainfall (mm) were employed for the years 1989-1993.[320] However, meterological data is represented as 46 regions, unlike agricultural data which is segregated into the 49 voivodships (counties). Thus, the rainfall trends are duplicated for a number of voivodships (counties) in order to complete the data set.[321] The physiography, land structure and land cover of each quarter[322] were other aspects considered in the duplication process (Dawson, 1982; and Szemberg interview, 1994; refer to Chapter 6 and Appendix I).

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[318]In fact, when a variable measuring 'size' was included in the regression analyses, statistically low t-ratios reinforced this argument.

[319]However, there are some agricultural operations where the influence of weather is less important. These include harvesting, livestock and diary farming. The statistical significance of this independent variable, nationally and regionally is tested in Chapter 6.

[320]Data were selected from GUS, 1990c, 1991d, 1992c, 1992f, 1993d and 1994.

[321]Therefore, data on the annual rainfall in the voivodships (counties) of Bialstok, Katowice and Lodz are used also for the nearby respective voivodships (counties) of Lomza, Opole and Skierniewice.

[322]The northwest had the highest annual average rainfall (7, 727.1 mm) of all four quarters, followed by the southeast (7, 285.8 mm); the southwest (7, 175.4 mm) and the northeast (4127.0 mm) (GUS, 1990c, 1991d, 1992c, 1992f, 1993d and 1994).

5.7 Summary

Chapter 5 has documented on three main themes: the limitations of data, in general; data collection in the transitional economies of CEE; and the variable specifications in this present study of arable productivity. Incomplete and potentially inaccurate data sets are symptoms of an economic system undergoing economic transformation (Brock, 1994; Johnson et al., 1994; and Bartholdy, 1995), and as such data extrapolation and intrapolation are two techniques used to overcome the difficulties arising from data omission. To conclude, the specification of this particular model of productivity is handicapped by both the limitations of Cobb Douglas production function theory (detailed in section 3.6), and the caveats relating to the empirical data (described here and earlier in Chapter 4).

Chapter 6

Regression[323]

'..The basic criteria for a well established production function should at least include positive estimated coefficients, statistically significant estimates and the inclusion of all conventional variables..' (Wong, 1986: 35).

6.1 Introduction

In Chapter Six the empirical analysis of Polish arable production is presented. A series of regressions are fitted to Polish agricultural data from the period 1988-1993 in order to gain insights into resource use, factor allocation and spatial diversification within Polish farming. The chapter is in three parts. The first (section 6.2) documents the exact specification of this model of Polish arable production. Part II (sections 6.3 to 6.5) focuses on the preliminary development of the regression technique to be adopted in this investigation, based upon those which have often been applied in agricultural production studies (detailed in Chapters 3 and 4). Stage I of the regression analysis consists of the method of Ordinary Least Squares (OLS)[324], as it is used extensively by economists. Stage II of regression involves Generalised Least Squares (GLS) estimation. This latter approach was utilised in order to eliminate the autocorrelation within the disturbance terms in the OLS regressions. The third stage (section 6.6) evaluates the aggregate national and regional production elasticities using the results generated from the GLS regressions. This is in preparation for the analysis in Chapter 7, where the results generated from this study of agricultural production are contextualised within earlier non-Polish and Polish farming production studies.

[323]The econometric programme 'Shazam' was used in all stages of regression.

[324]The Ordinary Least Squares estimator specifies a number of underlying assumptions: (i) Lack of multicollinearity assumption. The explanatory regressors are non-stochastic, and none of the regressors can be written as an exact linear combination of the remaining regressors. (ii) Zero mean assumption. The disturbances υ_{it} have zero means. (iii) Non-autocorrelated error assumption. The disturbances υ_{it} are serially uncorrelated. (iv) Homoscedasticity assumption. The disturbances υ_{it} have a constant variance. (v) Orthogonality assumption. The disturbances υ_{it} are normally distributed (Pesaran and Pesaran, 1991; and Thomas, 1993).

6.2 Model specification

The starting point for this analysis is the simplest Cobb Douglas production function, discussed in detail in Chapter 3 (see equation [3.13] in section 3.4). This took the form:

$$Q_t = TK_t^{\alpha} L_t^{\beta} \qquad [6.1]$$

where Q is output, T is an index of disembodied technological progress, L and K are labour and capital inputs respectively, t is time, α is the production elasticity (responsiveness) of output with respect to capital (holding labour constant) and β is the production elasticity of output with respect to labour (holding capital constant). It is assumed that α and β are usually positive fractions, where β may or may not be equal to $(1-\alpha)$, and capital intensity is measured by the size of exponent α, relative to β.[325]

By adding variables to the basic Cobb Douglas[326] specification, a more detailed model of

$$Q_{vt} = TN_{vt}^{\gamma} K_{vt-1}^{\alpha} F_{vt}^{\zeta} L_{vt}^{\beta} R_{vt}^{\theta} u_{vt} \exp\{DN+DK+DF+DL+DR+d\} \qquad [6.2]$$

Polish arable[327] production can be identified:

where

Q_{vt} is the aggregate[328] physical arable production of selected crops in voivodship (county) v and year t;

T is an efficiency parameter or index of disembodied technology;

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[325]Additional features of this function include: homogeneity of degree $(\alpha+\beta)$ and in the special case of $\alpha+\beta=1$, it is linearly homogeneous (Chiang, 1984; Gemma, 1989; Thirwall, 1994; and Thomas, 1994; see sections 3.4 and 6.7).

[326]The Cobb Douglas production function was used because of ease of manipulation with crude data and is well established in agricultural production literature (detailed in Chapters 3 and 4).

[327]A comparable productivity analysis focusing on 'livestock' (in 1000 tonnes) would complement this arable productivity study. The dependent variable: 'livestock' (including cattle, pigs and sheep, in 1000 tonnes) is regressed on the independent variables: buildings (including barns and drying sheds in 1000s); labour (in 1000s); and sale of concentrated industrial feed (in 1000 tonnes at t-1). A liveweight index is created using 420 kg per head a beef cattle; 200 kg per sow; 50 kg per piglet up to three months old; 100 kg per piglet 3-6 months old; 50 kg per sheep; 25 kg per sheep up to 1 year and 50 kg per sheep over 1 year old (Florkowski, Hill and Zareba, 1988; see Chapter 4). However, a productivity model of Polish livestock is beyond the confines of the thesis.

[328]Of 8 major crops: wheat, barley, rye, oats, potatoes, rapeseed and sugar, converted into 1000 tonne units (documented in section 5.5.1).

N_{vt} is the total area of cultivated land under selected crops[329] in voivodship (county) v and year t;

K_{vt-1} is lagged operative tractors[330] in voivodship (county) v and time t;

F_{vt} is fertiliser usage[331] in voivodship v (county) and time t;

L_{vt} is labour[332] in voivodship (county) v and time t;

R_{vt} is rainfall (mm) in voivodship (county) v and time t; and

u_{vt} is a disturbance term for voivodship (county) v and time t.

A series of dummy variables (D) was also incorporated to analyse the impact of economic stabilisation on the input-output relationship within Polish farming in the post 1989 period.[333] Specifically, the variables DN (land), DK (capital), DF (fertilisers), DL (labour) and DR (rainfall)[334] allow estimation of the degree to which the slope coefficients of the early transition period differ from the slope coefficients of the pre-transition period. For example, the value of DN represents the effect of a change in the area of land under cultivation on arable harvest yields after 1989. d embodies the dummy variable used to estimate the differential intercept, informing on whether a structural shift in levels of arable production took place during 1989-1993.

Three alternative breakpoints separate the periods designated as 'pre economic transition' and 'early economic transition'. These were set at the end of 1989 (as agricultural prices were liberalised completely in Poland on 1 August 1989 with 'Big Bang' (BB) macroeconomic stabilisation on 1 January 1990); the end of 1990; and the end of 1991 (privatisation of state-owned farms was initiated on 1 January 1992). Although the theoretical argument is that 1990

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[329] A quality-adjusted land variable generated very similar national and regional GLS land elasticity coefficients (described in section 5.5.2).

[330] A quality-adjusted capital variable produced comparable national and regional GLS capital elasticity parameters (see section 5.5.3).

[331] Refer to section 5.5.3.

[332] A quality-adjusted labour variable yielded corresponding national and regional GLS labour elasticity estimates (detailed in section 5.5.4).

[333] Chapter 7 documents Polish government agricultural policy until the year 2000.

[334] Justification for incorporating a differential slope coefficient for rainfall (DR) is based upon the fact that average annual rainfall per voivodship (county) increased considerably in the early transition period. During 1988-89, average annual rainfall (mm) per voivodship (county) was 526.14 mm rising to 553.54 mm during 1990-1993. In fact, the rise in magnitude of the DR estimate across the GLS regressions reflects the increase in average rainfall (mm) during 1990-1993 (see Tables 6.3 and 6.4; Tables IX.1-IX.8, Appendix IX and section 6.5).

was the dividing year between pre and early economic transformation, the individual breakpoints were used during the regression analysis for two specific reasons. First, a supply response from the primary sector to economic policy change is characteristically slow. This is owing to agriculture having a longer-run production cycle than other sectors in the economy and a natural lag between the forces of supply and demand. For example, crop cultivation may take as long as 9-12 months between its sowing season and its final stage of harvesting. Moreover, the pre-arranged output targets in (former) state farming production are likely to have aggrevated the institutional ridigities already in place and delayed further the impacts of economic transition on (former) socialised production (see section 6.5). Secondly, as the free-market price mechanism was being determined by emerging forces of demand and supply, unclear price signals would have frustrated the ability of the agricultural markets to function properly. Therefore, it was deemed appropriate to use all three breakpoints in order to analyse both the pace and extent of economic reform as well as its impingement on the Polish primary sector.

When the dividing year is set at 1989, the dummy variables are valued at '0' for 1988 and '1' for the remaining period (1989, 1990, 1991, 1992 and 1993). When the partition is marked as the end of 1990, the dummy variables equal '0' for 1988 and 1989 and '1' for the rest of the period. Lastly, when the end of 1991 symbolises the breakpoint, the dummy variables are '0' for 1988, 1989 and 1990 and '1' thereafter.

γ, α, ζ, β and Θ are the production elasticity coefficients of land, capital, fertiliser, labour and rainfall with respect to arable output (change in output/change in input, all other inputs remaining constant). In this study there are 49 voivodships (counties) in total, v=1, 2,.., 49[335] and six years, t=1988, 1989,.., 1993.

[335]The regional analyses divide Poland into four quarters: the northwest, northeast, southeast and southwest (spatial differentiation was detailed earlier in section 5.4.2).

Taking logarithms from both sides of [6.2] becomes:

$$\ln Q_{vt} = \ln T + \gamma \ln N_{vt} + \alpha \ln K_{vt-1} \ldots \qquad [6.3]$$

$$\ln F_{vt} + \beta \ln L_{vt} + \theta \ln R_{vt} + \ln u_{vt} + DN + DK + DF + DL + DR + \alpha$$

Part II of this chapter (sections 6.3 to 6.5) focuses on each stage of regression: the OLS and the GLS methods of estimation. As the GLS model generated the most appropriate estimations from both the national and regional data distributions, they are tabulated and analysed hereafter. Therefore, the GLS regression results reflect the interface of economic transition with the changing environment in the Polish agricultural sector.

6.3 Preliminaries[336]

The functional estimator used throughout the regressions is an unrestricted log-linear Cobb Douglas production function as it identifies empirically the sources of economic growth. Over and above its ability to estimate the output elasticities, the model can also determine whether the private or (former) socialised sectors of Polish farming experienced constant, decreasing or increasing returns to scale during the embryonic years of economic transformation (documented in section 6.7). Thus $\ln Q_{vt}$ is the dependent variable, while $\ln N_{vt}$, $\ln K_{vt-1}$, $\ln F_{vt}$, $\ln L_{vt}$ and $\ln R_{vt}$, combined with all the dummy variables are the independent variables specified in the model (defined earlier in section 6.2 and Chapter 5). Each dummy variable was restricted to 'zero' during this introductory phase of estimation.

[336] There were two arable production models developed initially. Whilst the first used 'the number of tractors (1000s), lagged by one year', the second applied 'the number of tractors (1000s) in year t' as their measures for capital (documented in section 5.5.3). However, as the production elasticity coefficients and their corresponding t-ratios of both variables were almost identical, the results relating to model two (capital at time t) are omitted from the thesis.

6.3.1 Stage I: OLS

Table 6.1: Preliminary national results derived from the OLS estimations

Independent Variables	Private p1	Private p2	(Former) state
Constant	1.534 (2.953)	0.852 (4.069)	3.200 (4.818)
Land (N)	0.892 (16.951)	0.923 (19.292)	0.656 (15.992)
Capital (K)	0.140 (2.358)	0.121 (2.095)	0.501 (5.411)
Fertilisers (F)	0.114 (5.373)	0.117 (5.534)	0.215 (5.803)
Labour (L)	0.147 (4.437)	0.138 (4.234)	0.178 (3.106)
Rainfall (R)	-0.354 (-1.434)	n.a.	-0.449 (-4.674)
R^2 (adjusted)	0.85	0.85	0.95

t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratio <±2)
[Source: Compiled by Author]

Table 6.1 above summarises the results derived from fitting regressions to the Polish national agricultural data sets using OLS. The production elasticity coefficients relating to both sector's regression complemented a priori expectations generally. It was anticipated that all the independent variables would exhibit positive and statistically significant (t-ratio >±2) elasticity parameters; the private sector would generate large land and labour elasticity estimates as private sector farming is land and labour-intensive (detailed in 2.3); and the (former) state sector would produce large capital and fertiliser elasticity coefficients, owing to heavy, state-oriented government subsidisation (see 2.4). However, three deviations helped to undermine the use of this modelling technique. First, a larger (former) socialised labour elasticity estimate than anticipated, suggesting a labour-intensive agricultural production process; and second, the negative and statistically insignificant (t-ratio <±2) private sector rainfall elasticity coefficient. Over and above a precursory analysis of the signs and magnitude of the output elasticities, additional statistical inference relating to the disturbance terms discredited the application of the OLS estimation altogether. The Durbin Watson (D-W)[337] is a routine test statistic for detecting autocorrelation[338] (Baltagi, 1995). Within this analysis, the D-W estimate exhibited evidence of positive first-order serial correlation in the OLS disturbance terms. Accordingly, the null hypothesis of zero serial correlation was rejected at the 5 per cent significance test level as the D-W test statistics were less than the estimated lower limit (d_L) level.[339] Based upon this diagnostic test, the OLS estimations are not efficient as they violate one of the properties of the Best, Linear, Unbiased Estimator (BLUE).[340] When any of the underlying assumptions of estimation are encroached, other modelling techniques are used to remedy the shortfalls associated with OLS estimation. In this case, it is the GLS (AR (1)) approximation which is used to remove both temporal and cross-sectional positive first-order serial correlation from the OLS disturbance terms.[341]

6.3.2 Stage II: GLS

Table 6.2 below presents the Stage II GLS estimation with first-order autoregressive error terms[342] (AR (1)).[343] Although the production elasticity estimates did not fulfil every a priori hypothesis (detailed in 6.3.1), nevertheless this econometric model of arable production has produced the BLUE to the agricultural data as the autocorrelation within the disturbance terms was successively removed. Therefore, it was the GLS method of estimation which was selected

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337 In short, the D-W test statistic is simply the ratio of the sum of squared differences (RSS) in successive residuals to the RSS (Baltagi, 1992).

338 Autocorrelation is when the disturbance terms are correlated with each other either contemporaneously (between years) and/or cross-sectionally (between panels) (Baltagi, 1992).

339 The D-W test statistic is tabulated up to n=200 (Gujarati, 1992). At n=200 and when k=5, d_L=1.718 and d_U=1.820. As n=294 in the national investigation, the d_L and d_U are linearly extrapolated and the approximated values are: d_L=1.818 and d_U= 1.854.

340 See Gujarati, 1992: 95.

341 Used by Johnson et al., 1994 (additional documentation in Appendix VIII).

342 In essence, the autoregressive (AR) option (exact likelihood method) was designed to combat the classical problem of serial autocorrelation in the error terms (Hildreth and Lu, 1960; Pesaran, 1972; and Beach and MacKinnon, 1978). The assumption is that the disturbances υ_{it}, follow a stationary autoregressive process with stochastic initial values (Baltagi, 1995). Other variations of this theme include the Cochrane-Orcutt and the Gauss-Newton iterative methods. Any of the AR model types are in sharp contrast with the simple error component model where it is assumed that the only correlation over time is a result of the presence of the same individual across the panel (Pesaran and Pesaran, 1991; and Baltagi, 1992).

343 AR (1) specification assumes that: $v_{it}= \rho v_{i,t-1} + \epsilon_{it}$ $|\rho|<1$. The v_{it} denotes the residual disturbance which varies with time and the cross sectional variant (Pesaran and Pesaran, 1991; and Baltagi, 1992).

as the most suitable type of regression for the complete national and regional data sets (dummy variables inclusive). It is these GLS regression results which form the basis of the rest of this chapter and underpin the analysis within the following chapter.

Table 6.2: Preliminary national results derived from the GLS, AR (1) estimations

Independent Variables	Private	(Former) state
Constant	0.875 (2.505)	2.757 (7.050)
Land (N)	0.886 (21.944)	0.729 (21.537)
Capital (K)	0.117 (2.528)	0.396 (6.496)
Fertilisers (F)	0.154 (11.382)	0.179 (7.604)
Labour (L)	0.176 (7.140)	0.132 (3.702)
Rainfall (R)	-0.095 (-0.569)	-0.346 (-6.157)
R^2 (adjusted)	0.99	0.99

t-ratios (from zero) at five per cent significance level in parentheses
[Source: Compiled by Author]

6.4 GLS regression results

Tables 6.3 and 6.4 below present the national GLS regression results generated from voivodship (county) level data on each sector of Polish agriculture. This means that 49 different sets of panel data describing the explanatory variables (output, land, capital, fertiliser, labour and rainfall) were used in the regression.

To distinguish the sectoral and regional imbalances in Polish agricultural structure and performance, the data were segregated further into eight distinct regions, similar to that used by Boyd (1988) (detailed in section 5.4.2). Tables IX.1-IX.8 in Appendix IX detail the GLS regression results derived from these regional data sets. As there were 15 voivodships (counties) in the area representing the northwest, the GLS regression was fitted to 15 panels of data connected to the explanatory variables (output, land, capital, fertiliser, labour and rainfall). In the regions known as the northeast, southeast and southwest, the number of panel data sets were 7, 13 and 14 respectively. At the first phase (p1 and s1), all the dummy variables (DN, DK, DF, DL, DR and d) were included in the regression. However, at the second and third phases (p2, p3, s2 and s3) of regression, the insignificant dummy variables were restricted to zero to improve the overall regression fit. In econometric modelling, statistical significance (1 or 5 per cent test level) of a variable is determined regularly from the t statistic. Quite simply, if the magnitude of the t-statistic is less than ±2, the independent variable in question has had a negligible impact on the dependent variable. Finally, the pre and early transition periods are partitioned at the year ending 1989, 1990 and 1991 consecutively. Extensive references are made to all of these tables in the proceeding analyses.

Table 6.3: Regression results generated by the private sector under GLS (AR(1))

	M=1989			M=1990		M=1991	
	p1	p2	p3	p1	p2	p1	p2
C[a]	47.990 (5.008)	12.049 (3.969)	8.542 (4.197)	20.843 (5.531)	17.357 (6.697)	6.315 (3.877)	4.293 (3.373)
N	0.701 (12.394)	0.869 (17.934)	0.908 (25.026)	0.809 (16.620)	0.842 (21.803)	0.865 (18.629)	0.898 (22.329)
K	0.190 (3.433)	0.157 (3.749)	0.172 (4.335)	0.273 (5.215)	0.299 (6.612)	0.160 (3.501)	0.162 (3.766)
F	0.185 (1.035)	0.110 (6.899)	0.107 (6.964)	0.133 (1.164)	0.230 (1.415)	0.151 (8.301)	0.150 (8.469)
L	0.189 (3.250)	0.114 (3.997)	0.106 (3.879)	0.205 (1.518)	0.070 (0.758)	0.147 (4.506)	0.127 (4.587)
R	-0.354 (-3.690)	-0.202 (-2.465)	-0.175 (-2.357)	-0.188 (-3.009)	-0.160 (-2.786)	-0.159 (-2.674)	-0.110 (-1.934)
DN	0.271 (3.306)	0.226 (1.488)	n.a.	0.226 (0.758)	n.a.	0.156 (0.473)	n.a.
DK	-0.132 (-1.492)	n.a.	n.a.	0.212 (0.628)	n.a.	0.104 (0.972)	n.a.
DF	0.236 (1.256)	n.a.	n.a.	0.199 (0.563)	n.a.	-0.130 (-4.136)	-0.110 (-3.919)
DL	-0.111 (-1.702)	n.a.	n.a.	-0.262 (-1.424)	n.a.	-0.362 (-1.759)	n.a.
DR	0.542 (4.790)	0.347 (3.645)	0.311 (3.671)	0.342 (3.812)	0.288 (3.717)	0.599 (5.771)	0.513 (5.371)
d	-4.274 (-4.834)	-2.554 (-3.632)	-2.037 (-3.847)	-2.406 (-3.235)	-2.229 (-3.072)	-3.288 (-4.095)	-2.760 (-4.446)
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; n.a. denotes restriction=zero (as t-ratio <±2)
t-ratios (from zero) at five per cent significance level in parentheses
p=private; s=(former) state; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall
[Source: Compiled by Author]

Table 6.4: Regression results generated by the (former) state sector under GLS (AR (1))

	M=1989		M=1990		M=1991	
	s1	s2	s1	s2	s1	s2
C[a]	14.116	6.141	10.590	10.226	23.684	27.855
	(2.699)	(4.235)	(3.171)	(3.322)	(6.636)	(6.981)
N	0.587	0.577	0.648	0.645	0.576	0.592
	(8.576)	(9.726)	(13.629)	(14.685)	(14.036)	(15.247)
K	0.335	0.420	0.301	0.305	0.434	0.361
	(2.643)	(7.447)	(3.913)	(6.130)	(6.319)	(6.816)
F	0.487	0.543	0.501	0.505	0.380	0.365
	(5.311)	(7.542)	(6.928)	(7.094)	(10.319)	(9.371)
L	0.310	0.256	0.338	0.338	0.344	0.375
	(3.259)	(3.443)	(5.748)	(6.054)	(7.266)	(8.224)
R	-0.602	-0.517	-0.608	-0.606	-0.603	-0.619
	(-5.196)	(-7.284)	(-7.779)	(-8.438)	(-9.387)	(-9.886)
DN	0.151	0.165	0.105	0.107	0.207	0.171
	(2.061)	(2.769)	(1.945)	(2.391)	(3.656)	(3.956)
DK	0.357	n.a.	0.030	n.a.	-0.167	n.a.
	(0.697)		(0.080)		(-1.565)	
DF	-0.326	-0.383	-0.216	-0.221	-0.124	-0.125
	(-3.524)	(5.415)	(-2.861)	(-2.992)	(-2.645)	(-2.549)
DL	-0.232	-0.175	-0.244	-0.242	-0.269	-0.338
	(-2.289)	(-2.231)	(-3.524)	(-3.928)	(-3.940)	(-5.280)
DR	0.445	0.338	0.681	0.671	0.779	0.777
	(3.352)	(5.204)	(6.349)	(6.666)	(7.513)	(7.542)
d	-0.971	n.a.	-2.698	-2.607	-4.012	-3.974
	(-0.927)		(-3.032)	(-3.109)	(-5.437)	(-5.346)
R^2	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; n.a. denotes restriction=zero (as t-ratio <±2)
t-ratios (from zero) at five per cent significance level in parentheses
p=private; s=(former) state; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall
[Source: Compiled by Author]

6.5 Analysis of the national and regional GLS[344] regression results

Part II of this chapter evaluates the GLS national and regional regression results.[345] On the one hand, the results generated from the national data sets reflect the relative factor share of Polish arable production. On the other hand, the regional results reflect spatial agricultural diversification. Two important issues are considered in this section. First, t-tests at the five per cent significance level are used to verify the relative importance of the dependent variables (when t-ratio (from zero) >±2). Second, the differential intercepts (d) and differential slope coefficients (DN, DK, DF, DL and DR) are reviewed as they illustrate the effects that post-1989 economic policy had on Polish agricultural output. Hitherto, localised qualitative information is used to assist in the regional aspects of the investigation. To begin, the R^2 estimates are high (0.99) in all GLS regressions illustrating approximately 99 per cent of the variations in the dependent variable is explained by the independent variables (goodness of fit).

The production elasticity coefficients of the conventional independent variables (land, capital, fertiliser and labour) are positive in the national GLS regressions generated by each sector of Polish agriculture. Any increases in the agricultural factors of production would have raised arable harvest yields. However, the rainfall elasticity parameters generated by both sector's GLS regressions are actually negative suggesting variations in annual average rainfall depressed total arable production during 1988-1989. Indeed, while the rainfall elasticity coefficients of the (former) state sector's GLS regressions are ≈-0.6, the private sector's estimates are ≈-0.2[346] implying (former) socialised agricultural output was more adversely affected by weather variations than private production.[347] This may be explained by the fact that 55 per cent of (former) state-

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[344]Despite the existence of autocorrelation in the OLS disturbance terms and their omission from the thesis, the production elasticity coefficients and their corresponding t-ratios were similar in magnitude to the GLS results. Comparative regression results strengthen the robustness of this model of production.

[345]See Tables IX.1-IX.8, Appendix IX.

[346]See p1, p2, p3, s1 and s2 in Tables 6.3 and 6.4 above.

[347]The national and regional GLS regression results conflict with a priori expectations as a positive correlation between rainfall and arable production was anticipated. However, this may be oversimplifying the relationship as other factors, such as irrigation would come into force. On the other hand, the perverse results may have been caused by model misspecification and/or inadequate data. Types of specification errors include omission of a relevant variable, inclusion of an irrelevant variable and an incorrect functional form. Excluding a relevant variable, the coefficients of the variables retained in the model are generally biased as well as inconsistent, the error variance is incorrectly estimated, the standard errors of estimators are biased, and therefore the usual hypothesis-testing procedure becomes invalid. 'Home-produced fertilisers' and the 'number of horses actively involved in agricultural production' are two examples of theoretically relevant variables, which have been omitted from the analysis due to data inadequacy. On the other hand, including an irrelevant

owned arable land was located in the north western region of Poland in 1988, which incidentally had the lowest annual rainfall per voivodship (county) during 1988-1989.[348] However, the differential slope coefficients for rainfall (DR) are positive and individually statistically significant in the national GLS regressions suggesting annual rainfall boosted both sectors' production levels in the post-1989 period.[349] In fact, the average annual rainfall per voivodship (county) rose during 1990-1993[350], despite the drought year of 1992 (presented in Appendix I).

The rainfall elasticity coefficients generated in all regional GLS analyses confirm the suppositions made from the national GLS regression results. Once again, the rainfall elasticity estimates are negative[351] and larger in the (former) socialised production functions.[352] Similarly, the differential slope coefficients for rainfall (DR) are positive and statistically significant verifying average rainfall raised agricultural output after 1989.

The t statistics illustrate that most of the independent variables are statistically significant[353] at the five per cent level in the national GLS regressions validating their importance to arable harvest production. However, fertiliser application and manpower were statistically insignificant in the private national GLS regressions when the year ending 1990 divides the pre and early transition periods.[354] This suggests both of these variables were extraneous to private agricultural yields. There are three reasons which may explain these phenomena. First, the demand for commercially produced fertilisers is likely to be low anyway as home-produced manure is used

variable in the model still gives us unbiased and consistent estimates of the coefficients of the true model, the error variance is correctly estimated and the standard hypothesis-testing is still valid. If the wrong functional form is chosen, the estimated coefficients may be biased estimates of the true coefficients (Gujarati, 1992).

[348]Annual average rainfall during 1988-1989 per voivoidship in the northwest was 452.97 mm, in contrast with 593.42 mm in the northeast, 558.64 mm in the southeast, and 499.52 mm in the southwest (GUS, 1990c, 1991d, 1992c, 1992f, 1993d and 1994).

[349]Section 6.6 details the aggregate early transition national and regional production elasticity coefficients (1989-1993).

[350]The annual average rainfall per voivodship during 1988-1989 was 526.14 mm, rising to 553.54 mm during 1990-1993 (GUS, 1990c, 1991d, 1992c, 1992f, 1993d and 1994).

[351]Except for the private northwest (see Table IX.1, Appendix IX).

[352]See Tables IX.1-IX.8, Appendix IX.

[353]T-ratio >±2.

[354]The t-statistic for fertiliser=1.415 and the t-statistic for labour=0.758 (see p2 when M=1990 in Table 6.3 above).

extensively in Polish private farming.[355] Second, highly aggregated measures of fertiliser application may distort the true effects of fertilisers on Polish harvest yields (refer to Chapters 4 and 5). Third, it may be simply under representation of the agricultural labour data set (see below).

The GLS regional regressions have also produced some adverse results, manifested as negative and statistically insignificant labour and fertiliser elasticity estimates. For example, the negative and statistically insignificant fertiliser elasticity parameters of the northwest,[356] northeast,[357] and south eastern[358] private sectors and the north eastern[359] (former) state sector imply the application of fertilisers had no affect on harvest yields in these quarters. There are a number of reasons which may explain these events-both economic and statistical. First, total private fertiliser consumption was the lowest in the northeast of all four regions throughout 1988-1993[360], aggrevating the existing problems of poor land quality. Second, there may have been a re-direction of north western and north eastern private sector investment expenditure into other factor resources, such as land, machinery (other than tractors), farm buildings or livestock (detailed in section 7.3.3). Third, it is possible that there is a lower demand for commercially produced fertilisers in the private southeast as home-produced fertilisers are cheaper and easily accessible, especially as south eastern private sector farmers use horses regularly in agricultural production (Nowicki, 1992; and Szemberg, 1992c; see sections 4.2.4 and 4.4.3). Fourth, average (former) state sector fertiliser application per arable hectare was the second lowest in the northeast of all (former) state sectors in 1988[361] despite the fact that agricultural land has a lower

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[355]This independent variable is omitted from the arable production model because data on home-produced fertilisers are not collected in Poland (see section 5.5.3). Perhaps, this is one reason for misspecification in the model.

[356]F=-0.208 (t-ratio=-1.753) in p2 when M=1989; and F=-0.065 (t-ratio=-0.460) in p2 when M=1990 (see Table IX.1, Appendix IX).

[357]F=-0.028 in p3 (t-ratio= -0.155) when M=1989, M=1990 and M=1991 (see Table IX.2, Appendix IX).

[358]F=-0.203 (t-ratio= -1.827) in p2 when M=1989 (see Table IX.3, Appendix IX).

[359]F=-0.247 (t-ratio= -0.766) in s2 when M=1990 (see Table IX.6, Appendix IX).

[360]176.3 thousand tonnes of fertiliser were consumed in the northeast in 1988 (representing 41 per cent of average consumption), falling to 167.5 thousand tonnes in 1993 (representing 52 per cent of average consumption; see Table V.1, Appendix V).

[361]451.4 kgs per cultivated hectare in this region; the northwest had the highest application with 543 kgs per cultivated hectare (see Table V.2, Appendix V).

classification in this quarter. Fifth, the small sample regional data distributions with a limited number of observations may have caused incorrect statistical estimation, or more simply, inadequate data sources may have generated erroneous regressions (refer to Chapter 4 and section 5.4.2).

The negative and statistically insignificant (t-ratio <±2) labour elasticity coefficients in the private southeast[362] and (former) state sector northwest[363] suggest manpower resources had little impact on arable production levels in both these areas during 1988-89. As the south eastern region of Poland has a high rural population density and rural overpopulation, it is likely that the marginal productivity of labour is low or even negliglible in this quarter. Indeed, an additional qualitative aspect is that older-aged farmers dominate the agricultural setting here, dampening average and marginal labour productivities further (see section 5.4.2). Therefore, the labour-output relationship of arable production in the southeast still reflects the historical patterns of rural settlement (detailed also in 2.3, 5.4.2). The negative labour elasticity coefficient in the north western (former) state sector GLS regressions may indicate labour as a factor resource was not being fully utilised (allocative inefficiency)[364] and hidden unemployment existed within socialised farming during 1988-1989 (refer to section 7.5.3).

The negative and statistically significant differential intercepts (d) of both private[365] and (former) state[366] national GLS regressions imply a distinct downward shift from pre to early transition. In fact, the increasing magnitude of d across the regressions suggests the fall in both private[367] and (former) socialised arable production was more pronounced in the later part of the

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[362]L=-0.222 (t-ratio=-3.682) in p2 when M=1990 and L=-0.231 (t-ratio=-3.278) in p2 when M=1991 (see Table IX.3, Appendix IX).

[363]L=-0.718 (t-ratio=-3.375) in s2 when M=1989; L=-0.102 (t-ratio=-0.977) in s2 when M=1990; and L=-0.364 (t-ratio=-0.323) in s2 when M=1991 (see Table IX.5, Appendix IX).

[364]Allocative efficiency is where, given input prices, factors are used in proportions which maximise producer profits. The relevance of the concept of efficiency (allocative efficiency in particular) has been questioned extensively in the literature (Rizzo, 1979; Pasour, 1981; and Colman and Young, 1993) principally in those cases where prices are distorted, and producers have imperfect knowledge and may pursue goals other than profit maximisation.

[365]d=-2.037 (t-ratio=-3.847) in p3 when M=1989; d=-2.229 (t-ratio=-3.072) in p2 when M=1990; and d=-2.760 (t-ratio=-4.446) in p2 when M=1991 (see Table 6.3 above).

[366]d=-2.607 (t-ratio=-3.109) in s2 when M=1990 and d=-3.974 (t-ratio=-5.346) in s2 when M=1991 (refer to Table 6.4 above).

[367]And the t-ratios are significant (>±2) in all early transition regressions (presented in Table 6.3 above).

post-1989 period. The lagged supply-side response is owing to both the inherent sluggish nature of agricultural markets, and the institutional framework of (former) state-managed farms. For example, a long-term (3-5 year) production cycle and operational restrictions, such as production targets, are features of (former) state-managed farming (documented in section 2.4). Nevertheless, the results show structural change in both sectors of Polish agriculture took place in response to macroeconomic stabilisation.

In common with the national results, the differential intercepts (d) are negative and statistically significant in the GLS regressions generated by both the private and (former) state sector regressions of the northwest[368], southeast[369] and southwest[370] of Poland in the post-1989 period. Moreover, the t-ratios associated with d are insignificant until after 1990 in the (former) socialised regions of the northwest and southeast and after 1991 in the southwest. Therefore, the results imply a definite depression in arable output after 1989, in reaction to macroeconomic stabilisation. Once again, economic policy implications affected regional (former) socialised production one or two time periods later than the private sector. It is likely that the institutional framework of state-managed farms are again accountable for this rather slow response. In addition, the magnitude of the differential intercepts in (former) socialised regional farming GLS regressions (≈-4.7) reflect the larger fall in arable harvest yields than private regional agricultural GLS regressions (≈-4.5). This is due to the restructuring of state-managed farms; an aspect of the macroeconomic stabilisation policies. However, an anomaly has occurred in the north eastern private and (former) state GLS regressions. The t-ratios of the differential intercepts[371] generated by both sectors are statistically insignificant across all regressions. Therefore these results suggest

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[368]d=-7.640 (t-ratio=-5.798) in p2 when M=1989; d=-4.790 (t-ratio=-6.275) in p2 when M=1990; and d=-5.188 (t-ratio=-8.040) in p2 when M=1991. d=-2.178 (t-ratio=-2.802) in s2 when M=1990; and d=-4.386 (t-ratio=-6.372) in s2 when M=1991 (see Tables IX.1 and IX.5, Appendix IX).

[369]d=-5.968 (t-ratio=-5.028) in p2 when M=1989; and d=-0.655 (t-ratio=-3.366) in p2 when M=1990. d=-5.109 (t-ratio=-2.959) in s3 when M=1990, and d=-4.801 (t-ratio=-2.914) in s2 when M=1991 (refer to Tables IX.3 and IX.7, Appendix IX).

[370]d=-4.552 (t-ratio=-3.109) in p2 when M=1989; d=-3.134 (t-ratio=-2.498) in p2 when M=1990; and d=-4.319 (t-ratio=-2.889) in p2 when M=1991. d=-5.891 (t-ratio=-4.079) in s2 when M=1991 (documented in Tables IX.4 and IX.8, Appendix IX).

[371]d=-0.378 (t-ratio=-0.884) in p2 when M=1989; d=-2.563 (t-ratio=-1.783) in p1 when M=1990; and d=-0.472 (t-ratio=-0.188) in p1 when M=1991. d=6.750 (t-ratio=1.672) in s1 when M=1989; d=3.978 (t-ratio=0.939) in s1 when M=1990 and d=6.941 (t-ratio=1.365) in s1 when M=1991 (refer to Tables IX.2 and IX.6, Appendix IX).

the post-1989 decline in arable output was not as severe in either of these quarters.[372] As this is simply not the case, it is possible that misspecification of the model has occurred.

The differential slope coefficients generated in both national and regional regressions show some changes to the factor-product relationship.[373] DN represents the differential slope parameters which measure the changing relationship between cultivated land and arable production during early transition (1989-1993). As the t-ratios identified with DN are statistically insignificant in the private national GLS[374] regressions, the change in private arable land under cultivation after 1989 had made little contribution to national private arable output. This is plausible as the area of private cultivated land increased only marginally during 1989-1993.[375] A similar situation arises in the northwestern[376] and northeastern[377] regions of private farming.[378] Perhaps this reflects a marginally less land-intensive approach to farming than the private south eastern[379] zone where the DN estimates are positive and significant.[380] As for the south western[381] private GLS regressions, positive DN estimates and their significant t-ratios can only be explained by better soils in this zone (Dawson, 1982; and Szemberg interview, 1994; see also 2.5.3, 5.4.3,

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[372]Private north eastern output fell by 15.1 and 13.5 per cent consecutively during 1990-92 and north eastern (former) socialised production fell by 65.5 per cent during 1989-93 (GUS, 1987b, 1988b, 1989b, 1990c, 1991b, 1992b and 1993c; detailed in section 5.4.2).

[373]As a cautionary note, analysis of the differential slope coefficients on an individual basis represents only one aspect of the overall situation. For example, a change in land resources may be a response to a change in other factor resources or it may be cause other factors to change.

[374]Refer to Table 6.3 above.

[375]Detailed in section 5.5.2.1; see also Table V.1, Appendix V.

[376]DN=-0.214 (t-ratio=-0.806) in p1 when M=1989; DN=0.039 (t-ratio=0.173) in p1 when M=1990; and DN=0.253 (t-ratio=0.333) in p1 when M=1991 (see Table IX.1, Appendix IX).

[377]DN=0.198 (t-ratio=0.586) in p2 when M=1989; DN=0.304 (t-ratio=0.453) in p1 when M=1990; and DN=0.073 (t-ratio=0.249) in p1 when M=1991 (presented in Table IX.2, Appendix IX).

[378]Cultivated land increased by 3.87 per cent in the northwest and fell by 1.10 per cent in the northeast during 1989-1993 (GUS, 1988b, 1988d, 1989e, 1990e, 1991e, 1992g and 1993f; see Table V.1, Appendix V).

[379]DN=0.310 (t-ratio=3.781) in p2 when M=1989; DN=0.118 (t-ratio=1.086) in p1 when M=1990; and DN=-0.130 (t-ratio=-0.970) in p1 when M=1991 (refer to Table IX.3, Appendix IX).

[380]Arable production may have become more land-intensive in the southeast in response to the withdrawal of other factors from the production processes, for example capital or fertilisers.

[381]DN=0.595 (t-ratio=4.219) in p2 when M=1989; DN=0.458 (t-ratio=3.835) in p2 when M=1990; and DN=0.445 (t-ratio=3.311) in p2 when M=1991 (see Table IX.4, Appendix IX).

5.5.2.1 and 7.2.3).

In contrast, the statistically significant t-ratios of the DN estimate in the (former) state sector national GLS regressions[382] suggest (former) state sector land continued to make a positive contribution to socialised production during 1989-1993. This is presumably because the total area of (former) state-owned cultivated land actually continued to rise until 1990.[383] The delay in the disposal of (former) state-owned land reflects the longer-term institutional arrangements associated with privatisation, such as development of private property rights (see 1.4.2.1) and land registration. However, the regional (former) socialised regressions produced a variety of responses. In fact, the DN parameters of the north western[384] and eastern[385] (former) state GLS regressions suggest the fall in arable land (through set-aside or privatisation) significantly depressed state output after 1990.[386] In the southeast, the decline in the area of land under cultivation during 1989-1993 (-49.2 per cent) was statistically insignificant[387]; and in the southwest[388], the fall in cultivated land (-36.7 per cent) had actually increased socialised crop yields. As the area of arable land set-aside for non-agricultural purposes[389] did not actually affect south eastern or south western state harvests during early transition, perhaps there is evidence of allocative inefficiency and/or under utilisation of land in former state-managed farming.[390]

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[382]DN=0.165 (t-ratio=2.769) in s2 when M=1989; DN=0.107 (t-ratio=2.391) in s2 when M=1990 and DN=0.171 (t-ratio=3.956) in s2 when M=1991 (summarised in Table 6.4 above).

[383]There were 2, 013.9 thousand hectares of (former) state-owned cultivated land in 1990. It fell by 20.1 per cent, 13.9 per cent and 16.9 per cent consecutively during 1990-1, 1991-2 and 1992-3 (GUS, 1988b, 1988d, 1989e, 1990e, 1991e, 1992g and 1993f; Table V.2, Appendix V provides further information).

[384]DN=-0.116 (t-ratio=-3.038) in s2 when M=1990 (see Table IX.5, Appendix IX).

[385]DN=-0.496 (t-ratio=-3.468) in s2 when M=1990; DN=-0.452 (t-ratio=-2.712) in s2 when M=1991 (refer to Table IX.6, Appendix IX).

[386]The area of (former) state cultivated land fell by 41.2 per cent in the northwest and by 45.7 per cent in the northeast during 1989-1993 (GUS, 1988b, 1988d, 1989e, 1990e, 1991e, 1992g and 1993f; presented in Table V.2, Appendix V).

[387]DN=0.180 (t-ratio=1.842) in s2 when M=1989; DN=0.334 (t-ratio=1.112) in s1 when M=1990; DN=0.291 (t-ratio=0.943) in s1 when M=1991 (see Table IX.7, Appendix IX).

[388]DN=0.195 (t-ratio=2.648) in s2 when M=1989; DN=0.407 (t-ratio=4.881) in s2 when M=1990; and DN=0.636 (t-ratio=7.813) in s2 when M=1991 (summarised in Table IX.8, Appendix IX).

[389]44 per cent and 21.6 per cent of (former) state land was laid fallow in the southeast and the southwest respectively at the end of 1993 (APA, 1994; see Table VI.1, Appendix VI).

[390]Refer to sections 2.5.3, 5.5.2.1 and 7.2.3; and Table V.2, Appendix V.

DK depicts the differential slope parameters which measure the changing relationship between capital and arable production during the post 1989 period. DK's t-ratios are statistically insignificant in both private (p1) and (former) state (s1) national regressions, together with all regions of the private sector[391] and the (former) north western[392] state zone. Correlation between tractive force and arable production did not alter markedly during 1989-1993 in these areas. However, use of the disembodied technical progress hypothesis may have resulted in underestimation of the role of capital in private agricultural production (see section 3.5). On the one hand, the results reflect the stabilisation of privately-owned operative capital, as the processes of private sector tractorisation near completion. On the other hand, the regressions imply the decline in (former) state-owned capital did not impress upon state arable harvest yields until after 1991.[393] In fact, the national level of (former) state-owned capital resources did not fall significantly until 1991-2 anyway.[394] There are three reasons for the sluggish withdrawal of socialised capital resources from state arable production. First, it is owing to the long-run production cycle within (former) state farming. Second, absorption of (former) state-owned inventories by the private farming sector was especially difficult as farmers were being subjected to a cost-price squeeze. Third, saturation of the private sector markets due to tractorisation would have hampered further the disposal of (former) state-owned capital.

The t-ratios affiliated with DK in the south eastern[395] state sector regressions are also statistically insignificant implying that the largest decline of capital resources during 1989-1993[396] did not actually influence arable production levels. As (former) state-managed farms of the

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[391]Except the northwest where DK=-0.631 (t-ratio=-3.969) in p2 when M=1989. The stabilisation in operative capital affected arable output after 1989. This is probably because private farmers in this quarter are more dependent upon capital resources than the other regions (as evident by the higher capital/labour ratio (see Table V.1 and IX.1, Appendices V and IX).

[392]Refer to Table IX.5, Appendix IX.

[393]As the (former) state DK coefficients and their t-ratios increase in magnitude across the national regressions. DK=0.357 (t-ratio=0.697) in s1 when M=1989; and DK=-0.167 (t-ratio=-1.565) in s1 when M=1991 of the GLS regressions (presented in Table 6.4 above).

[394](Former) state-owned capital fell by 12.7 per cent in 1991-2 and by 23 per cent during 1992-3 (GUS, 1987a, 1988c, 1989c, 1990d, 1991c, 1992c, 1993d and 1994; see Table V.2, Appendix V).

[395]Refer to Table IX.7, Appendix IX.

[396]-35.3 per cent during 1989-1993 (GUS, 1987a, 1988c, 1989c, 1990d, 1991c, 1992c, 1993d and 1994; see Table V.2, Appendix V).

southeast had the highest ratio of capital per arable hectare of all four state regions[397], the underlying implication may be over capitalisation and/or under utilisation of capital as a factor resource. Perhaps, this is further evidence of allocative inefficiency in socialised south eastern farming. In contrast, the DK coefficients in the (former) state sectors of the southwest[398] are negative and statistically significant (t-ratio >±2) after 1990 and 1991 respectively. Thus, the decline in the number of operative tractors depressed arable output in the embryonic years of economic transformation. Finally, the DK estimates of the north eastern (former) state sector regressions remained positive and statistically significant implying a rise in capital and a consequential rise in arable output. Specification errors are a likely cause for this irrational result, especially in light of the unexpected (former) socialised north eastern differential intercepts (detailed above).[399]

DF symbolises the differential slope parameters which measure the changing relationship between fertiliser application and arable harvests in the post-1989 period. The DF coefficients and their statistically significant t-ratios suggest the decline in the use of fertilisers reduced the overall level of (former) socialised arable production[400] immediately after 1989[401], but did not affect total private arable output until after 1991.[402] The tardy response may be explained by six specific factors. First, the instant withdrawal of heavy government subsidisation from socialised farming in 1989 would have reduced the state farms' purchasing capabilities almost immediately.[403] Second, there is a natural time lag between agricultural supply and demand: private farmers

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[397]There were 4.7 arable hectares to every tractor in the southeast in 1993. In contrast, there were 12.5, 9.6 and 11.1 arable hectares to every tractor in the northwest, northeast and southwest (former) state sectors (GUS, 1987a, 1988c, 1989c, 1990d, 1991c, 1992c, 1993d and 1994; Table V.2, Appendix V provides additional information).

[398]DK=-0.353 (t-ratio=-2.141) in s2 when M=1991 (see Table IX.8, Appendix IX).

[399]Refer to 2.5, 5.5.1, 5.5.2.1 and 7.3.3; see also Table V.1, Appendix V.

[400]And production in the (former) state southeast (DF=-0.366 (t-ratio=-3.051) in s3 when M=1989). The decline in fertiliser consumption affected former socialised farming in the southwest after 1990 (DF=-0.485 (t-ratio=-3.594) in s2 when M=1990) (summarised in Tables IX.7 and IX.8, Appendix IX).

[401]DF=-0.383 (t-ratio=-5.415) in s2 wen M=1989; DF=-0.221 (t-ratio=-2.992) and DF=-0.125 (t-ratio=-2.549) in s2 when M=1991 in the GLS regressions (see Table 6.4 above).

[402]DF=-0.110 (t-ratio=-3.919) in p2 when M=1991 (refer to Table 6.3 above).

[403]Detailed in sections 1.1, 2.5 and 5.5.3.2.

production decisions are affected by food demand.[404] Third, some private farmers may have continued to purchase fertilisers despite the considerable price rises, in fear of future price increases. Fourth, private farmers are more likely to use a substitute good anyway: the use of home-produced manure is very popular in Polish private farming. Fifth, the decline in private farming incomes in relation to other economic sectors became more apparent after 1990. Sixth, the Poland and Hungary Assistance for the Reconstruction of the Economy (PHARE) funds allocated to the supply of input programmes diminished after 1990[405] (Kent Interview, 1994). In addition, the DF estimates across all (former) state sector GLS regressions are larger than the private DF estimates (≈-0.4 against ≈-0.2). The decline in fertiliser consumption was more pronounced in the (former) socialised sector of farming throughout the post-1989 period simply because the application of fertilisers was 51.6 per cent higher in the socialised farming sector than the private sector in the base year[406] (see also Table V.2, Appendix V).

The DF coefficients generated by the private northwest[407] and southeast[408] GLS regressions suggest fertiliser consumption continued to boost arable harvest yields until after 1989 and 1990 respectively. There are no rational explanations[409] for these results as average annual

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[404]The demand for food continued to rise immediately after agricultural price liberalisation on 1 August 1989 (refer to section 2.5).

[405]First, the monies derived from the EU for the supply of feed/plant protection went into a counterpart, multi-purpose fund for all economic sectors. The counterpart fund was kept by the Polish side for indicative programmes. Second, the DGVI food aid programme together with another counterpart fund were used exclusively to assist the development of rural agriculture. Now 90 per cent of the funds come under the central control of the Foundation of Assistance Programmes for Agriculture (FAPA), a management unit located in the Ministry of Agriculture. The allocation of PHARE committments in ECU (m) are as follows:

1990	100
1991	17
1992	23
1993	30
1994	no allocation as the budget was leftover from previous years (see section 2.5).
1995	30+ (Kent interview, 1994).

[406]In 1988, average fertiliser application per cultivated hectare in state agriculture was 467.2 kgs; in contrast with 308.1 kgs in private farming (GUS 1989c, 1990d, 1991c, 1992c, 1993d and 1994; Appendix V provides further analysis).

[407]DF=0.374 (t-ratio=3.170) in p2 when M=1989; DF=0.148 (t-ratio=1.415) in p1 when M=1990 and DF=-0.123 (t-ratio=-1.580) in p1 when M=1991 (see Table IX.1, Appendix IX).

[408]DF=0.408 (t-ratio=3.711) in p2 when M=1989; DF=0.326 (t-ratio=2.365) in p1 when M=1990; DF=-0.102 (t-ratio=-1.630) in p1 when M=1991 (refer to Table IX.3, Appendix IX).

[409]Poor regressions may be a result of inadequate data; problems associated with the accurate measurement of fertiliser consumption (detailed in section 5.5.3); specification errors in the model and/or the small sample size.

fertiliser application per hectare fell by 53.5 per cent in the northwest and the southeast had the lowest average annual application per hectare throughout 1988-1993,[410] exacerbated by poor land quality (documented in section 5.4.3; see also Table V.1, Appendix V). In contrast, the DF estimates of the private and (former) socialised sector regressions of the northeast,[411] together with the (former) state northwest[412] and private southwest[413] are statistically insignificant implying little change in the fertiliser-output association in the post-1989 period. Extensive use of farm-produced manure on private farms throughout 1988-1993 is a likely explanation for the constancy in the output-fertiliser association. However, the (former) state sector results imply the 66.6 per cent fall in fertiliser usage in the northwest and the 64.5 per cent decline in the northeast during 1989-1993 had left (former) state sector harvest yields unmodified. Perhaps this is due to the fact that average fertiliser application per cultivated hectare of socialised land was marginally higher in northern Poland than in southern Poland in the base year[414] (summarised in Table V.2, Appendix V).

DL signifies the changing relationship between active agricultural employment[415] and Polish arable production during the post 1989 period. Negative DL estimates and their statistically significant t-ratios in the national (former) state sector GLS[416] regressions[417] illustrate the decline

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[410]133.4 average kgs of fertilisers per arable hectare were used in the southeast, in contrast with 260.4 kgs, 178.8 kgs and 152.6 kgs in the northwest, northeast and southwest (GUS 1989c, 1990d, 1991c, 1992c, 1993d and 1994; Table V.1, Appendix V contains additional information).

[411]DF=0.172 (t-ratio=0.684) in p1 when M=1989; DF=-0.119 (t-ratio=-0.234) in p1 when M=1990; and DF=-0.212 (t-ratio=-1.644) in p1 when M=1991. DF=-0.728 (t-ratio=-1.824) in s1 when M=1989; DF=-0.363 (t-ratio=-1.357) in s1 when M=1990; and DF=-0.271 (t-ratio=-0.441) in s1 when M=1991 (see Tables IX.2 and IX.6, Appendix IX).

[412]DF=-0.269 (t-ratio=-1.269) in s1 when M=1989; DF=-0.207 (t-ratio=-1.026) in s1 when M=1990; and DF=-0.214 (t-ratio=-0.380) in s1 when M=1991 (refer to Table IX.5, Appendix IX).

[413]DF=-0.137 (t-ratio=-1.482) in p1 when M=1989; DF=-0.289 (t-ratio=-1.089) in p1 when M=1990; and DF=-0.332 (t-ratio=-1.680) in p1 when M=1991 (see Table IX.4, Appendix IX).

[414]In 1988, average fertiliser application per cultivated hectare in the north western and north eastern socialised farming sectors were 542 kgs and 451.4 kgs; the average application across all regions was 467.2 kgs per cultivated hectare (GUS 1989c, 1990d, 1991c, 1992c, 1993d and 1994; presented in Table V.2, Appendix V).

[415]It is acknowledged that regression results relating to both the private and (former) socialised labour variables may be inaccurate as omitted values resulted in data intrapolation and extrapolation (documented in section 5.5.4).

[416]DL=-0.175 (t-ratio=-2.231) in s2 when M=1989; DL=-0.242 (t-ratio=-3.928) in s2 when M=1990; and DL=-0.338 (t-ratio=-5.280) in s2 when M=1991 (see Table 6.4 above).

[417]And in the southwest. DL=-0.367 (t-ratio=-3.002) in s2 when M=1989; DL=-0.560 (t-ratio=-5.161) in s2 when M=1990; DL=-0.717 (t-ratio=-5.610) in s2 when M=1991 (refer to Table IX.8, Appendix IX).

of state sector manpower[418] reduced (former) state arable production from 1989 onwards. This is largely owing to the institutional change associated with private property rights (see 1.4.2.1.); as (former) state-owned farms are privatised, redundancies ensue[419], confirming Hypothesis 1, section 1.5. Similar results were produced by the southern regional private regressions. Indeed, large DL coefficients of the southwest[420] reflect the substantial decline in rural employment[421] and mass emigration to Germany during 1989-1993. The negative DL coefficients of the southeast[422] may reflect the retirement of older farmers in this region (detailed in section 7.5.3). In contrast, the positive and statistically significant DL coefficients of the northwest private regressions[423] intimate labour continued to boost arable production. However, as north western registered rural employment fell by 10.3 per cent during 1989-1993,[424] these results may appear quite perverse. There are two possible explanations which could account for this irregularity. First, perhaps the 10.3 per cent decline is representative of the least productive segment of the workforce, say for example the older-aged farming group. Indeed, if this is the case, then there is some evidence of a behavioural change and/or reorganisation in the agricultural workforce. As larger and technologically more advanced farms are frequently found in this region, this is quite probable. Alternatively, it may be due simply to inadequate data sources.

The statistically insignificant t-ratios of the DL coefficients generated by the private

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[418]There are no reliable data on (former) state sector employment. However, estimated state employment fell by 42.2 per cent in the southwest during 1989-1993 (GUS, 1990b and 1992f; see sections 5.5.4.1 and 7.5.3 and Table V.2, Appendix V).

[419]Detailed in sections 2.5, 5.5.4.1 and 7.5.3; and Table VI.2, Appendix VI.

[420]DL=-0.628 (t-ratio=-4.780) in p2 when M=1989; DL=-0.465 (t-ratio=-3.968) in p2 when M=1990; and DL=-0.475 (t-ratio=-3.844) in p2 when M=1991 (see Table IX.4, Appendix IX).

[421]Rural employment fell by 22.3 per cent in the southwest (GUS, 1990b and 1992f; see section 7.5.3 and Table V.1, Appendix V).

[422]DL=-0.376 (t-ratio=-4.058) in p2 when M=1989 (summarised in Table IX.3, Appendix IX).

[423]DL=0.822 (t-ratio=5.194) in p2 when M=1989; DL=0.191 (t-ratio=2.768) in p2 when M=1990 (see Table IX.1, Appendix IX).

[424]GUS, 1990b and 1992f; presented in sections 5.5.4.1 and 7.5.3; see also Table V.1, Appendix V.

national[425] GLS[426] regressions, and the (former) state sectors in the northwest, northeast and southeast[427] illustrate the decline in the private sector labour force[428] and the fall in (former) state sector employment[429] did not affect arable output after 1989. Although published agricultural data indicated a reduction in private sector rural employment between 1988 and 1993, other empirical research[430] unearthed evidence of an urban-rural labour migration in response to the collapse of former state-operated industries. Many people travelled to the countryside either in search for new employment opportunites or for dual employment, working on the farm and in nearby conurbations.[431] Therefore, the agricultural labour employment statistics used here may not entirely reflect the role of labour in the arable production process.

In summary, the production elasticity coefficients of both national and regional private and (former) state sector regressions reflect the relative allocation of factor resources (see Chapter 7). The regional regressions reflect Polish agricultural diversification. The differential intercepts prove there was a distinct fall in total harvest yields after economic stabilisation, whilst the differential slope parameters indicate the input-output relationship of (former) socialised farming changed considerably in the post-1989 period. In short, this is due to institutional change associated with agricultural restructuring (land privatisation; the withdrawal of government subsidies; private property rights and the shedding of factor resources: labour and capital). Finally, inadequate agricultural data and/or specification errors affiliated to the production model may be the cause for some irrational regional results. Therefore, the results contained in this analysis of

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[425]DL=-0.111 (t-ratio=-1.702) in pl when M=1989; DL=-0.262 (t-ratio=-1.424) in pl when M=1990; and DL=-0.363 (t-ratio=-1.759) in pl when M=1991 (see Table 6.3 above).

[426]And the northeast. Perhaps this is because farming in the northeast is marginally less labour-intensive than its southern counterparts (DL=0.164 (t-ratio=0.148) in pl when M=1989; DL=-0.232 (t-ratio=-0.395) in pl when M=1990; DL=-0.126 (t-ratio=-0.533) in pl when M=1991) (refer to Table IX.2, Appendix IX).

[427]They were caused presumably by hidden rural unemployment in the socialised farms, especially as the (former) state farms were often the sole employer in the rural communities.

[428]Rural national private sector employment fell annually by approximately 4 per cent during 1989-1993 and by 13.8 per cent in the northeast during 1989-1993 (GUS, 1990b and 1992f; see sections 5.5.4.1 and 7.5.3 and Table V.1, Appendix V).

[429]Estimated rural state employment fell by 56.9 per cent in the northwest; 53.6 per cent in the northeast; and 52.2 per cent in the southeast (hypothesised in section 1.5; GUS, 1990b and 1992f; see Table V.2, Appendix V).

[430]Detailed in sections 1.4.2, 5.3 and 7.1.

[431]This is happening in Rzgow and Wagry; the two study areas where primary data collection occurred (see section 5.3).

Polish agricultural production (1989-1993) are consistent with earlier studies of transitional economies, in that problems associated with data have occurred (see Chapter 5).

The third and final part of this chapter (sections 6.6 and 6.7) determines the national and regional aggregate production elasticity estimates. The production elasticities of the independent variables measure the factor-product relationship of arable production in the pre-transition period. The differential slope coefficients reveal how that relationship changed between 1989-1993 in response to economic transformation. The derivation of the aggregate production elasticities throughout 1988-1993 could inform on resource use, factor allocation[432] and socio-economic development in the Polish primary sector (Hypothesised in section 1.5).

6.6 The early transition national and regional aggregate production elasticity coefficients (1989-1993)

This section outlines the methodology used to obtain the aggregate production elasticities during 1988-1993, in preparation for the forthcoming analysis in Chapter 7. The GLS national and regional regression results when '1989' is the dividing year between the pre and early-transition periods were used for the analysis.[433] This is because it was the first (official) year of Poland's rapid economic restructuring programme towards a market-oriented economy[434] (detailed in Chapters 1 and 2).

To estimate the early transition aggregate production elasticities, the differential intercepts are added to the constant term and the production elasticity coefficients of the explanatory variables (N, K, F, L and R) are combined with the differential slope estimates (DN, DK, DF, DL and DR) when the t-ratios are statistically significant. For example, by summing the land elasticity coefficient (γ) of the pre-transition period with its differential slope coefficent (DN) in the early transition period, it is possible to measure the total change in arable production with respect to the change in cultivated land during early transition (1989-1993). Therefore, equation [6.3] is re-

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[432]Based upon the assumption of perfect competition (see Chapter 3).

[433]Excerpts are taken from Tables 6.3 and 6.4 above and Tables IX.1-IX.8, Appendix IX.

[434]Tables X.1-X.6, Appendix X contain the national and regional early transition aggregate production elasticity coefficients at the two other breakpoints: 1990-1993 and 1991-1993.

arranged as:[435]

$$\ln Q_{vt}=(\ln A+d)+(\gamma+DN)\ln N_{vt}+(\alpha+DK)\ln K_{vt-1}.. \qquad [6.4]$$

$$+(\zeta+DF)\ln F_{vt}+(\beta+DL)\ln L_{vt}+(\theta+DR)\ln R_{vt}+\ln u_{vt}$$

and the private national aggregate GLS regression becomes:

$$\ln Q_{vt}=(8.542-2.037)+(0.908+n.a.)\ln N_{vt}+(0.172+n.a.)\ln K_{vt-1}.. \qquad [6.5]$$

$$+(0.107+n.a)\ln F_{vt}+(0.106+n.a.)\ln L_{vt}+(-0.175+0.311)\ln R_{vt}+\ln u_{vt}$$

Similarly, the (former) state national aggregate GLS regression becomes:

$$\ln Q_{vt}=(6.141+n.a.)+(0.577+0.165)\ln N_{vt}+(0.420+n.a.)\ln K_{vt-1}.. \qquad [6.6]$$

$$+(0.543-0.383)\ln F_{vt}+(0.256-0.175)\ln L_{vt}+(-0.517+0.338)\ln R_{vt}+\ln u_{vt}$$

Table 6.5 below summarises the national aggregate production elasticity coefficients generated by each sector of Polish farming under the GLS regressions and forms part of the forthcoming analysis in Chapter 7. The t-ratios (from zero) at the five per cent significant level are in parentheses.

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[435]From Gujarati, 1992: 269.

Table 6.5: Early-transition national regression results for the private and (former) state sectors using GLS (1989-1993)

	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	Private			(Former) state		
Intercept	8.542 (4.197)	-2.037 (-3.847)	6.505	6.141 (4.235)	n.a.	6.141 (4.235)
Land (N)	0.908 (25.026)	n.a.	0.908 (25.026)	0.577 (9.726)	0.165 (2.769)	0.742
Capital$_{t-1}$ (K)	0.172 (4.335)	n.a.	0.172 (4.335)	0.420 (7.447)	n.a.	0.420 (7.447)
Fertiliser (F)	0.107 (6.964)	n.a.	0.107 (6.964)	0.543 (7.542)	-0.383 (-5.415)	0.160
Labour (L)	0.106 (3.879)	n.a.	0.106 (3.879)	0.256 (3.443)	-0.175 (-2.231)	0.081
Rainfall (R)	-0.175 (-2.357)	0.311 (3.671)	0.136	-0.517 (-7.284)	0.338 (5.204)	-0.179 (-7.284)

t-ratios (from zero) at five per cent significance level in parentheses

n.a. denotes restriction=zero (as t-ratio <±2)

[Source: Compiled by Author]

The regional aggregate production elasticity parameters are derived from the GLS regional regressions in the same way. The regional aggregate estimates illustrate the geographical divisions that exist within the Polish primary sector and form another aspect of the investigation carried out in Chapter 7.

Recalling Equation [6.4]:[436]

$$\ln Q_{vt} = (\ln A + d) + (\gamma + DN)\ln N_{vt} + (\alpha + DK)\ln K_{vt-1} \dots \qquad [6.7]$$

$$+(\zeta + DF)\ln F_{vt} + (\beta + DL)\ln L_{vt} + (\theta + DR)\ln R_{vt} + \ln u_{vt}$$

[436]From Gujarati, 1992: 269.

For example, the private north western aggregate GLS regression becomes:

$$\ln Q_{vt} = (7.478 - 7.640) + (0.443 + n.a.)\ln N_{vt} + (0.772 - 0.631)\ln K_{vt-1} \ldots \quad [6.8]$$

$$+(-0.208 + 0.374)\ln F_{vt} + (0.306 + 0.822)\ln L_{vt} + (0.266 + 0.620)\ln R_{vt} + \ln u_{vt}$$

and the (former) state north western aggregate GLS regression becomes:

$$\ln Q_{vt} = (0.547 + n.a.) + (1.126 - 0.393)\ln N_{vt} + (0.583 + n.a.)\ln K_{vt-1} \ldots \quad [6.9]$$

$$+(0.427 + n.a.)\ln F_{vt} + (-0.718 + 0.569)\ln L_{vt} + (0.164 + n.a.)\ln R_{vt} + \ln u_{vt}$$

Tables 6.6 and 6.7 below summarise the regional aggregate early transition production elasticity parameters for each sector of Polish agriculture. The t-ratios (from zero) are in parentheses (see also Chapter 7).

Table 6.6: Early-transition GLS regression results generated by the private sector, by regions (1989-1993)

	Private					
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	NW			NE		
I	7.478 (1.578)	-7.640 (-5.798)	-0.162	25.636 (3.566)	n.a.	25.636 (3.566)
N	0.443 (3.578)	n.a.	0.443 (3.578)	0.759 (12.874)	n.a.	0.759 (12.874)
K	0.772 (5.765)	-0.631 (-3.969)	0.141	0.339 (1.494)	n.a.	0.339 (1.494)
F	-0.208 (-1.753)	0.374 (3.170)	0.166	-0.028 (-0.155)	n.a.	-0.028 (-0.155)
L	0.306 (0.722)	0.822 (3.780)	1.128	0.602 (5.837)	n.a.	0.602 (5.837)
R	0.266 (2.041)	0.301 (3.450)	0.567	-0.450 (-3.271)	n.a.	-0.450 (-3.271)
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	SW			SE		
I	42.905 (2.746)	-4.552 (-3.109)	38.353	6204.60 (8.937)	-5.968 (-5.028)	6205.50
N	0.668 (4.956)	0.595 (4.219)	1.263	0.477 (6.155)	0.310 (3.781)	0.787
K	0.242 (0.701)	n.a.	0.242 (0.701)	0.528 (4.816)	n.a.	0.528 (4.816)
F	0.181 (5.940)	n.a.	0.181 (5.940)	-0.203 (-1.827)	0.408 (3.711)	0.205
L	0.430 (3.931)	-0.628 (-4.780)	-0.198	0.295 (0.771)	-0.376 (-4.058)	-0.081
R	-0.503 (-2.607)	0.694 (3.150)	0.191	-0.762 (-4.818)	0.628 (3.380)	-0.134

t-ratios (from zero) at five per cent significance level in parentheses;
n.a.denotes restriction=zero (as t-ratio <±2);
I=intercept; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall;
NW=Northwest; NE=Northeast; SE=Southeast; SW=Southwest

[Source: Compiled by Author]

Table 6.7: Early-transition GLS regression results generated by the (former) state sector, by regions (1989-1993)

	(Former) state					
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	NW			NE		
I	0.547 (-2.730)	n.a.	0.547 (-2.730)	336.134 (4.261)	n.a.	336.134 (4.261)
N	1.126 (8.469)	-0.393 (-2.912)	0.733	0.297 (2.587)	n.a.	0.297 (2.587)
K	0.583 (3.819)	n.a.	0.583 (3.819)	0.247 (0.769)	n.a.	0.247 (0.769)
F	0.427 (7.300)	n.a.	0.427 (7.300)	0.271 (0.917)	n.a.	0.271 (0.917)
L	-0.718 (-3.375)	0.569 (2.723)	-0.149	0.848 (5.185)	n.a.	0.848 (5.185)
R	0.164 (2.198)	n.a.	0.164 (2.198)	-0.734 (-3.440)	n.a.	-0.734 (-3.440)
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	SW			SE		
I	77.867 (5.149)	n.a.	77.867 (5.149)	6.075 (6.396)	n.a.	6.075 (6.396)
N	0.605 (8.609)	0.195 (2.648)	0.800	0.838 (27.481)	n.a.	0.838 (27.481)
K	0.414 (4.978)	n.a.	0.414 (4.978)	0.360 (3.203)	n.a.	0.360 (3.203)
F	0.272 (1.307)	n.a.	0.272 (1.307)	0.406 (3.178)	-0.366 (-3.051)	0.040
L	0.461 (4.214)	-0.367 (-3.002)	0.094	0.268 (1.847)	n.a.	0.268 (1.847)
R	-0.524 (-4.192)	n.a.	-0.524 (-4.192)	-1.153 (-7.294)	0.370 (2.991)	-0.783

t-ratios (from zero) at five per cent significance level in parentheses;
n.a.denotes restriction=zero (as t-ratio <±2);
I=intercept; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall;
NW=Northwest; NE=Northeast; SE=Southeast; SW=Southwest
[Source: Compiled by Author]

6.7 Degrees of Homogeneity (1989-1993)

The use of an unrestricted log-linear Cobb Douglas production function as a functional estimator determines whether the private or socialised sectors of Polish farming experienced constant, decreasing or increasing returns to scale during 1989-1993. The sum of the aggregate production elasticity coefficients inform on the relative degrees of homogeneity. When the aggregate production elasticities, $((\gamma+DN)+(\alpha+DK)+(\zeta+DF)+(\beta+DL)+(\Theta+DR))=1$, the function is linearly homogeneous and the production function is experiencing constant returns to scale: that is, if inputs are increased by x, output expands by x. When $((\gamma+DN)+(\alpha+DK)+(\zeta+DF)+(\beta+DL)+(\Theta+DR))>1$, the production function has increasing returns to scale, and if, for example, inputs are doubled, output increases four times. When $((\gamma+DN)+(\alpha+DK)+(\zeta+DF)+(\beta+DL)+(\Theta+DR))<1$, the production function has decreasing returns to scale: and if, for example, inputs are increased by 8 times, output only increases 4 times (see Chapter 3).

The GLS regression results generated in this empirical investigation suggest both Polish farming sectors had a degree of homogeneity $\neq 1$. Indeed, the sum of the aggregate national production elasticity coefficients[437] suggest the private and (former) socialised sectors experienced increasing returns to scale during 1989-1993, despite economic transition. Similarly, the sum of the aggregate regional production elasticity parameters[438] imply private farming in all quarters experienced increasing returns to scale in the post 1989 period. As for the (former) state sectors, the western quarters experienced increasing returns to scale[439] whilst the eastern quarters suffered decreasing returns to scale during early transition.[440] There are a number of theoretical and data-based arguments which offer some explanation for these rather unanticipated implications. First, the key assumptions which form the economic principles underlying production theory may not be entirely applicable to an economy frustrated by economic transition.[441] Second, problems

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[437]Using the results presented in Table 6.5 above.

[438]Using the results presented in Tables 6.6 and 6.7 above.

[439]This may have been generated by overestimation of the 'official' production indices in the (former) state sector, inflating measures of performance (detailed in section 5.2).

[440]Evidence of allocative ineffiicency in the (former) socialised agricultural sectors may explain the decreasing returns to scale (refer to section 6.5).

[441]For example, the production process is monoperiodic; all inputs and outputs are homogeneous; the production function together with the product and factor relationships are known with certainty; profit maximisation; transparent price mechanism to both consumers and producers (detailed in Chapter 3).

associated with unreliable data sets and possible specification errors in the production model limit any truly accurate conclusions being drawn.

6.8 Summary

Chapter 6 has been largely a statistically-based analysis of Polish arable farming during early economic transformation. The GLS regressions have shown an unrestricted log-linear Cobb Douglas model of production is compatible with Polish agriculture. The use of dummy variables within the production model measure the impact of economic stabilisation policies on Polish farming. Whilst total arable production fell considerably during the post 1989 period, the structure of (former) socialised arable production altered substantially, owing to the stuctural transformation of (former) state-managed farms. State sector employment suffered considerably: over 50 per cent of the workforce was made redundant (APA, 1994). However, it is more alarming that there were few indications of change in the private agricultural sector's input-output relationship during 1989-1993. As private sector farming is likely to remain predominantly land-intensive and, coupled with the fact that farming is intrinsically slow to develop, the future for private Polish farmers is distressing (pursued in Chapter 7). Furthermore, as the private agricultural sector is the main food producer in the rural community, its pace in development will affect the whole economy. Finally, the results derived in Chapter 6 have accentuated the caveats common in this type of study and have verified the conclusions drawn in Chapters 3, 4 and 5. Thus, while theoretical limitations in the Cobb Douglas production function exist (see Chapter 3), inadequate farming data (refer to Chapter 4), especially in the transitional economies (detailed in Chapter 5) have generated some irrational regression estimations and specification errors are likely to have occurred.

Chapter 7

Contextualisation of GLS Regression results

7.1 Introduction

This chapter has a number of objectives. First, to analyse the results from the present production-function based study (detailed in Chapter 6) of Polish agriculture within the context of previous empirical studies. Second, using national and regional production elasticities, to demonstrate the agricultural diversity that exists within Polish boundaries. The coefficients derived by the private north western quarter of Poland are focused on in particular, as it is cited as being the most advanced agricultural region in Poland. Third, to show that the private sector of Polish farming is at an earlier stage of agricultural development (hypothesised in section 1.5). Extensive empirical research gathered in Poland during 1993/4[442], together with a synopsis on present Polish government's agricultural strategies until the year 2000, complements the economic analysis of each part. Therefore Chapter Seven completes the empirical component of the thesis.

Prior to economic transition, food consumption in Central and Eastern European Countries (CEECs) was high relative to food consumption in Western countries at comparable levels of living standards.[443] During the initial years of transition, the domestic demand for food

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[442] (i) detailed in Chapters 1 and 5, sections 1.4.2 and 5.3.

(ii) Secondary source materials which are referenced extensively in this chapter include results from two comprehensive investigations of socio-economic transformation in the agricultural areas of Poland. The surveys were carried out on a representative sample of 186 villages across the whole of Poland during 1984-1988 and on 72 villages during 1988-1992 by Professor Szemberg, Faculty of Social Research, Institute of Agricultural And Food Economics in Warsaw.

[443]Indeed, food expenditure still absorbs a considerable proportion of total household expenditure, especially in the poorer CEECs, as presented below.

Agricultural wages in the CEECs relative to the EU (1994) and Food Expenditure as a Percentage of Total Household Expenditure (1993)

	Relative Agricultural Wages	Food Expenditure (% ofTotal Household Expenditure)
Bulgaria	9	48
Federal Czech Rep	20	32
Hungary	22	31
Poland	15	30
Romania	3	60
Slovenia	40	28

[Source: Hartmann, 1996: 21 and 24]

fell considerably.[444] Whether this decline becomes a permanent feature in the post-socialist states still remains unclear (Tangermann, Josling and Munch, 1994). Nevertheless, economic growth[445] has outstripped population growth in Poland since 1993 (0.4 per cent). A rise in disposable income is likely to result is a corresponding increase in the demand for food. However, higher demand in food, coupled with simultaneous development in the food processing industries may result in a shift in consumption[446] patterns, a factor which will presumably effect the long-term agricultural production function. For example, an increase in the demand for food not primarily produced in the CEECs or a rise in high-quality EU imports[447] resulting in surplus domestic produce (Wierczorek interview, 1993). Nevertheless, agricultural production in 2000 is likely to exceed the 1993 level by as much as 12.5-13.4 per cent. In order to satisfy this higher level of food demand, Polish agricultural agents need to create a more efficient agricultural framework within which to function.[448] A rise in agricultural production, coupled with the development of food processing industries, is likely to increase foreign agricultural trade competitiveness.[449] Rejuvenation of old trade links with the Former Soviet Union (FSU)[450] and former Comecon member states[451] together with the expansion of new trade routes with the European Union (EU) and the 'sunrise' economies[452] are still in their infancy, but will continue to grow in the forthcoming

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[444]By 20 per cent in 1990 (refer to section 2.5.1).

[445]4.3, 5.5 and 7 per cent in 1994, 1995 and 1996 (detailed in section 2.5.1).

[446]The increase in the level of disposable income and a rise in the standard of living is likely to lead to a cultural shift which is reflected in a change in diet, such as vegetarian, organic or healthfoods.

[447]Such as Dutch tomatoes, tropical fruits, beverages and higher quality dairy products (Smith interview, 1994; and Tangermann, Josling and Munch, 1994).

[448]To increase agricultural production capacity, both product specialisation at the farm level and a greater propensity for vertical integration must occur (Hughes and Santorum interviews, 1994; MAF 1994; and East European Markets, 1995).

[449]Although Polish farmers are already finding it difficult to compete against heavily subsidised EU agricultural products (see section 2.5).

[450]Although exports to countries of the FSU are recovering, given the massive economic difficulties in nearly all of the Commonwealth Independent States (CIS), prospects for agricultural exports from the CEECs may not be very promising for some time to come (Tangermann, Josling and Munch, 1994). Nevertheless, the Polish government's export policy aims to increase food exports to countries of the FSU by 30 per cent by 2000 (MAF, 1994).

[451]Detailed in 2.5.1 and 2.5.2.

[452]Where 75 per cent of food is imported (Wos interview, 1993).

period (Wos interview 1993; detailed in section 2.5).

This agricultural production analysis identifies and measures the most influential independent conventional and nonconventional variables on Polish harvests during 1989-1993. With these results, it is possible to test Hypotheses 2-7 (section 1.5) within the context of earlier Polish and non-Polish agricultural production studies. First, that the private sector of Polish farming is at an earlier stage of agricultural development than the (former) state sector[453] (Hypotheses 2-5). Second, that Polish agriculture is regionally distinctive with respect to production and, the private north western quarter demonstrates a more advanced system of agriculture. For example, the magnitude of the northwest aggregate[454] land elasticity estimate will be lower than its southern and eastern counterparts (Hypothesis 6); its capital and fertiliser elasticity coefficients will be greater in magnitude than those of the south and east[455] (Hypothesis 7). To complement the quantitative analyses, extensive empirical research[456], embracing present Polish government's agricultural policies[457] interpret the responses from both sectors of Polish agriculture to early Polish economic transition.

Chapter Seven is in 6 parts, each sub-dividing into three main topics. The first presents the production elasticities generated in this study (sections 7.2.1, 7.3.1, 7.4.1 and 7.5.1); and whilst the second focuses on earlier non-Polish agricultural production analyses (sections 7.2.2, 7.3.2, 7.4.2 and 7.5.2), the third subject concentrates specifically on previous investigations of Polish arable production, culminating with Polish government strategies till the year 2000 (sections 7.2.3, 7.3.3, 7.4.3 and 7.5.3). Thus, Part 7.1 is the Introduction. Parts 7.2-7.5 detail the independent variables: land; capital (tractors and fertilisers); and labour and Part 7.6 concludes this chapter.

Table 7.1 (below) illustrates the aggregate production elasticity estimates of the GLS

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[453]Fussell, 1965; Jones, 1967; Grigg, 1974; Harlan, 1975; Vogeler, 1981; Lonsdale and Endedi, 1984; Cornia, 1985; and Pacione, 1986.

[454]Defined in section 6.7.

[455]This is due largely to Polish historical development. The Western regions have a higher quality of land increasing production capacity; higher capital investment per arable hectare; larger private farm units leading to economies of scope and scale; the majority of (former) state-sector farms are located in this region; greater access to Western European product and capital markets (Szemberg interview 1994; refer to sections 2.4 and 5.4.2).

[456]Advised above.

[457]Concept of Social and Economic Policy for the Rural, Agricultural and Food Sectors till the year 2000, MAF, 1994.

regressions generated by both sectors of Polish farming during the embryonic years of Poland's economic transition.[458] Indeed, the period specified as early economic transition is 1989-1993. It includes the production elasticities for each chosen independent variable and their corresponding t-ratios. Table 7.1 forms the foundations of the empirical research performed on the period 1989-1993. Excerpts from it mould the economic analysis in the proceeding parts, and extensive references are made to it throughout this chapter.

Table 7.1: Early transition aggregate regression results generated by Polish Agriculture. under a Cobb Douglas arable production function

	Total P	NW	NE	SE	SW	Total S	NW	NE	SE	SW
I	6.505	-0.162	25.636 (3.566)	6205.50	38.353	6.141 (4.235)	0.547 (-2.730)	366.13 (4.261)	6.075 (6.396)	77.867
N	0.908 (25.026)	0.443 (3.578)	0.759 (12.874)	0.787	1.263	0.742	0.733	0.297 (2.587)	0.838 (27.481)	0.800
K	0.172 (4.335)	0.141	0.339 (1.494)	0.528 (4.816)	0.242 (0.701)	0.420 (7.447)	0.583 (3.819)	0.247 (0.769)	0.360 (3.203)	0.414 (4.978)
F	0.107 (6.964)	-0.208 (-1.753)	-0.028 (-0.155)	0.205	0.181 (5.940)	0.160	0.427 (7.300)	0.271 (0.917)	0.040	0.272 (1.307)
L	0.106 (3.879)	1.128	0.602 (5.837)	-0.081	-0.198	0.081	-0.149	0.848 (5.185)	0.058	0.094
R	0.136	0.567	-0.450 (-3.271)	-0.134	0.191	-0.179 (-7.284)	0.164 (2.198)	-0.734 (-3.440)	-0.783	-0.524 (-4.192)

t-ratios (from zero) in parentheses at 5 per cent significance level
P=private; S=(former) state; NW=northwest; NE=northeast; SE=southeast; SW=southwest
I=Intercept; N=cultivated Land; K=tractors; F=Fertilisers; L=Labour; R=Rainfall

[Source: Compiled by Author]

7.2 Land

Part 7.2 focuses upon 'Land', the most important independent variable in Polish arable production during 1989-1993, according to its' magnitude in the GLS regressions (defined in Chapter 6). As noted earlier, there are three main stages of analysis: a discussion of the aggregate land elasticity

[458]Selected from Tables 6.5, 6.6 and 6.7.

estimates generated by both sectors of Polish farming, a comparison of the aggregate land elasticity estimates with past agricultural production studies, initially non-Polish then specifically Polish-based. Finally, a review of current Polish government land management policies for the agricultural sector till the year 2000 closes each part.

7.2.1 The aggregate land elasticity coefficient

Table 7.2: Aggregate Land elasticity coefficients of Polish farming, 1989-1993

	Total	NW	NE	SE	SW
Private	0.908 (25.026)	0.443 (3.578)	0.759 (12.874)	0.787	1.263
State	0.742	0.733	0.297 (2.587)	0.838 (27.481)	0.800

t-ratio (from zero) at 5 per cent significance level in parentheses

[Source: Compiled by Author]

Tables 7.1 and 7.2 above present the national and regional aggregate land elasticity estimates generated by each sector of Polish farming in this study. The significant national t-ratios indicate 'land under cultivation' had the largest influence on private and (former) state arable production during 1989-1993. For example, it can be seen that a 1 per cent increase in the area of 'land' sown would have resulted in a private sector rise in crop yields of 0.91 per cent whereas for the (former) state sector, the corresponding figure would be 0.74 per cent. In support of Hypothesis 6 (section 1.5), the north western private aggregate land elasticity (0.443) estimate is lower than those generated by the south western (1.263)[459], south eastern (0.787) or north eastern (0.759) neighbours. The results imply private agricultural production is less land-intensive in north west Poland than in the remaining quarters (confirming Hypothesis 6, section 1.5). In contrary to expectations, the southeast (0.838) and south western (0.800) regions of the (former) state sector generated the highest aggregate land elasticity estimates during 1989-1993. Perhaps this can be explained by considering the pre-transition land elasticity coefficients, without incorporating the differential slope parameters. It can be seen that the northwest has the highest land elasticity coefficient (1.126) of all (former) state quarters (see Table 6.7). So, whilst the superior land

[459]The land elasticity estimate of the southwest is especially high because of its high land quality in this region (detailed in section 5.4.2).

quality[460] stimulated above average harvest yields in the pre-transition period, north western state-owned land set aside from production[461] in the early transition period severely depressed its overall magnitude (detailed in sections 5.4.2 and 6.5).

7.2.2 Earlier agricultural production studies: the 'land' elasticity coefficient

As documented earlier in section 1.4.2.2 and Chapters 3 and 4, cross-country, national or regional agricultural data[462] can be used as the basis for agricultural production function studies. Indeed, global agricultural production functions for market oriented[463] or for (former) socialist economies[464] may be established. The Cobb Douglas production function remains the most widely applied theoretical framework for such analyses with Ordinary Least Squares (OLS)[465], the most extensively used regression estimator (Trueblood, 1989; see Tables 1.1 and 7.3, section 3.7 and Appendix VIII).

Table 7.3 (documented also in Table 1.1) below summarises the major properties of earlier international, socialist, transition and national agricultural production studies and includes the aggregate land elasticity estimate generated by each sector of Polish farming in this study. Appendix VIII details the variable specifications used within each model.

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[460] One of the underlying assumptions of the model is that land quality is reflected in harvest yield (see section 5.5.2).

[461] (Former) socialised cultivated land fell by 40.6 per cent in the northwest during 1988-1993 (see Table V.2, Appendix V).

[462] See section 4.3.

[463] These will include agricultural data from industrialised and LDCs (Trueblood, 1989). For example, Antle (1983) measured global agricultural production across 66 countries in 1965 (detailed in Chapter 4 and sections 7.3.2, 7.4.2, and 7.5.2).

[464] For example, Wong's (1986) agricultural production study on 9 socialist countries during 1959-1978.

[465] Other estimators include Generalised Least Squares (GLS); Instrumental Variables (IV); and the Two-Stage or Three Stage Least Squares (3SLS) (Kennedy, 1994; detailed in sections 4.2).

Table 7.3: Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Land elasticity coefficient[k]	
	Cross-country studies						
Bhattacharjee (1955)	CD[a]	OLS[c]	Industrialised and LDCs	22	1952	0.36 (1.94)	
Hayami and Ruttan (1971, 1985)	CD	OLS	Industrialised and LDCs	38	1955 1960 1965	0.08 (1.21)	
Evenson and Kislev (1975)	CD	OLS	Industrialised and LDCs	36	1950 1960 1965 1968	0.03 (0.46)	
Nguyen (1979)	CD	OLS	Industrialised and LDCS	40	1955 1960 1965 1970 1975	-0.03 (-0.52)	
Yamada and Ruttan (1980)	CD	OLS	Industrialised and LDCs	42	1970	0.02 (0.26)	
	LDC subsample						
Antle (1983)	**CD**	OLS, PCR[d]	Industrialised[g] and LDCs[f]	66	1965	0.16[g] (1.77)	0.44[f] (11.28)
Kawagoe, Hayami and Ruttan (1985)	CD	OLS, PCR	Industrialised[g] and LDCs	43	1960 1970 1980	0.10[g] (3.19)	-0.07[f] (-1.03)
Lau and Yotopoulos (1968)	CD, TL[b]	OLS	Industrialised[g] and LDCs[f]	43	1960 1970 1980	0.31[g] (1.73)	0.86[f] (5.36)
Yotopoulos (1968)	CD	OLS	Epirus, Greece	1	1964	0.07 (0.06)	

Table 7.3 (contd): Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Land elasticity coefficient[k]
	Studies of Socialist farming					
Wong (1986)[466]	CD	PCR	Socialist	9	1959-1979	0.13 (16.10)
Wong & Ruttan (1983)[467]	CD	PCR	Socialist	8	1959-1979	0.13 (16.13)
Clayton (1980)[468]	CD	OLS	Soviet Union	1	1960-1975	0.20 (4.00)
Brooks (1983)[469]	CD	PCR	Soviet Union, US, Canada, Finland	4	1960-1979	0.34 (13.08)
	Studies of Transitional Agriculture					
Johnson et al. (1994)[470]	CD	ML[h]	Ukraine	1	1986-1991	0.399 to 0.709
Fleisher and Liu (1992)	CD	OLS	Transition Economy-China	1	1987-1988	0.70 (26.60)
Lin (1989)	CD	n.a.	Transition Economy-China	1	n.a.	0.47
Screene	CD	GLS[e]	Poland	1	1989-1993	0.908[p] 0.742[s] (25.026)

[a]=Cobb Douglas; [b]=Translog Production function; [c]=Ordinary Least Squares; [d]=Principle Components Regression; [e]=Generalised Least Squares (AR (1)); [f]=LDC subsample; [g]=Industrialised countries subsample; [h]=Maximum Likelihood; [j]=Appendix VIII provides further details; [k]=OLS estimate unless otherwise specified; [p]=private; [s]=(former) state; n.a. denotes not available
t-ratio (from zero) at five per cent significance level in parentheses

[Source: Yotopoulos (1968); Clayton (1980); Wong (1986); Trueblood (1989); Fleisher and Liu (1992); and Johnson et al. (1994)]

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[466] Wong's meta-production study focused on aggregate agricultural production for nine socialist countries (Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, Yugoslavia, USSR, and China) using time-series panel data between 1959 and 1978 (outlined in Table 7.3). A Cobb-Douglas production function formed the theoretical framework but the Principle Components Regression (PCR) technique was used to generate parameter estimates. In his estimation, he aggregated co-operative and (former) state sectors of farming omitting the divisions in land ownership. In contrast, this study divided the private and state sectors of agriculture because Poland is uncharacteristic of former socialist countries (Wong, 1986).

[467] Wong and Ruttan (1983) conducted a study of the eight socialist countries documented (East Germany is excluded because of incomplete data).

[468] Clayton conducted a cross-sectional analysis on fifteen Soviet Republics on five yearly intervals during 1960-1975 (Clayton, 1980).

[469] Brooks (1983) investigated the effects of climate on agricultural production during 1960-1979. His time-series cross country agricultural production analysis on 15 soviet republics, ten American states, four Canadian provinces and the nation of Finland (Wong, 1986).

[470] Regressions were run separately so that 12 estimates were generated in total for each variable. The largest and smallest are reported within this analysis (Johnson et al., 1994; documented in Chapter 4).

The Polish private aggregate land elasticity estimate (0.91) exceeds the general range of parameters (0.86 and -0.03) defined by all previous agricultural production studies[471] but the (former) state elasticity coefficient (0.74) falls neatly within it. The only study to have generated a land elasticity estimate similar in magnitude to the one produced by the private sector is the Less Developed Countries (LDCs) subsample in Lau and Yotoupoulos' (1968) study. Their results suggest a 1 per cent increase in 'the area of cultivated land' would have increased arable production by 0.86 per cent. As their land elasticity estimate was generated by an LDC subsample, one can speculate that their cross-sectional agricultural production function is consistent with private agriculture in Poland during 1989-1993. Furthermore, it would appear that Polish private farms are as land-intensive in their farming practices as Lau and Yotopoulos's (1968) LDCs subsample (Trueblood, 1989). As for the (former) state sector aggregate land elasticity estimate (0.74), its magnitude is similar to those derived in agricultural production studies of transitional farming in China (0.70) and the Ukraine (0.71) (Fleisher and Liu, 1992; and Johnson et al., 1994).

Elaborating on this theme, Cornia (1985) suggested agriculture to be generally more land-intensive and less capital or labour-intensive when it is at an earlier stage of development. As agriculture develops, tools and capital inventories become more accessible to farmers. Thus, whilst the magnitude of the capital or labour[472] elasticity estimate increases, the land estimate declines (Cornia, 1985). Therefore, the national private Polish land elasticity coefficient (0.91) complements earlier studies by Antle (1983) and Cornia (1985) and supports Hypothesis 2 (section 1.5) that Private Polish farming is indeed at an earlier stage of agricultural development, comparable with agriculture in LDCs. In contrast, a lower national aggregate land elasticity estimate generated by the (former) state sector suggests it to be less land-intensive and at a later stage of agricultural development.

The disparity in the magnitude of the land elasticity parameters derived by agricultural production-based analyses reveal certain associated problems with its estimation (Trueblood, 1989). For example, Nguyen (1979) together with Kawagoe, Hayami and Ruttan (1985), generated negative land elasticity coefficients (-0.03 and -0.07, as shown in Table 7.3) which

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[471]Pooled data on the LDCs was represented by a dummy variable in studies by Nguyen (1979), Antle (1989), Kawagoe, Hayami and Ruttan (1985) and Lau and Yotopoulos (1968) to test for significant differences, outlined in Table 7.3 and section 4.3 (Trueblood, 1989).

[472]Outlined in 7.3.2 and 7.5.2.

indicate that an increase in the 'cultivated area' would have actually depressed agricultural output (Trueblood, 1989). Despite a Marxist philosophy underpinning the economic and political framework of (former) socialist agriculture, the heterogeneity of the primary sectors of (former) socialist countries[473] has also contributed to this diversity of land elasticity estimates. Yotopoulos' (1968) study of Greek agriculture generated an insignificant land[474] elasticity coefficient, but did not offer an explanation for the low t-ratio, focusing instead on the capital and labour elasticity estimates. One can only conclude that the mountainous terrain of the area was incompatible with arable cultivation. Other criticisms include those from Moll (1988)[475] and Lau and Yotopoulos (1968).[476] In fact, any direct comparisons made or conclusions drawn between agricultural production studies may prove inconclusive. This is because of the contrasting level of analysis, nature of the data, time periods, variable(s) specification and the alternative regression techniques adopted in these studies (illustrated in Table 7.3 and Appendix VIII). Ultimately, each agricultural production study is data driven since data availability and accessibility may determine the variables chosen or at least effect the way a variable is defined (documented earlier in Chapters 3 and 4).

Thus to conclude, it has been seen that cross-country agricultural production studies have tended to generate land elasticity coefficients ranging between 0.36 and -0.03, while socialist models have produced estimates ranging between 0.34 and 0.13. Models of Chinese and Ukrainian agriculture, based on periods of economic transition, have generated land elasticity estimates as high as 0.70 and 0.71 (see Table 7.3). However, the size of the land elasticity estimate in national agricultural studies of LDCs and South Asian countries is generally higher,

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[473]For example, farm size distributions would have resulted in economies of scale and scope. Yet, they were not uniform. In the (former) state farms averaged 5000 hectares in size but were as large as 50,000 hectares in Hungary (Borek interview, 1994). In contrast, the smallest Polish (former) state farm was approximately 250 hectares in size whereas the largest was 5700 hectares in 1993 (MAF, 1993).

[474] Land input was measured as the cultivated area, converted into standard units by allowing for differences in productivity, especially for irrigation (Yotopoulos, 1968).

[475]Challenging the findings of Kawagoe, Hayami and Ruttan (1985), Moll (1988) argued that the returns to scale of aggregate industrialised countries was much higher than farm-level data analysis in the individual industrialised countries suggested. In response, the authors stressed that the technological leaps in industrialised countries over recent years have led to substantial
increases in the use of tractor and mechanical technology which would inflate the capital elasticity coefficient, therefore increasing the total sum of elasticities and hence the returns to scale (Trueblood, 1989).

[476]The land elasticity coefficient is generally 'too low' across all meta-production studies. Their meta-production study generated a land elasticity estimate of 0.86 for LDCs and 0.31 for industrialised countries (Trueblood, 1989; illustrated in Table 7.3).

simply because agriculture is more land-intensive and at an earlier stage of agricultural development. Strictly speaking, the private national aggregate land elasticity estimate of 0.91 during 1989-1993 falls outside of the LDC range, conflicting with Hypothesis 2 (section 1.5). However, as the magnitude of the coefficient is especially large, the results still suggest private farming in Poland is comparable with developing agriculture, but, in contrast, the (former) state sector may be at a later stage of agricultural development.

The following section provides the context of earlier Polish agricultural production investigations. A summary of present Polish government agricultural land management policies till the year 2000[477] closes the second part of this chapter.

7.2.3 Polish agricultural production studies: the 'land elasticity coefficient'

Table 7.4 below summarises the national aggregate land elasticity estimates generated by the private and (former) state sectors of Polish agriculture within earlier Polish agricultural production studies. These studies include those by Boyd (1988, 1991)[478] and Florkowski, Hill and Zareba (1988).[479] Appendix VIII outlines the variable(s) specification(s).

Table 7.4: Features of Polish Agricultural Production Functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of Study	Land elasticity coefficient[k]
Boyd (1988, 1991)	CD[a]	IV[b]	Poland	1	1960-1982	0.44[p] 0.10[s] (42.94) (82.37)
Florkowski, Hill and Zareba (1988)	CD	3SLS[c]	Poland	1	1956-1983	1.81[p] 0.003[s] (3.03) (0.02)
Screene	CD	GLS[d]	Poland	1	1989-1993	0.91[p] 0.74[s] (25.026)

[a]=Cobb Douglas; [b]=Instrumental Variable Function; [c]=Three Stage Least Squares; [d]=Generalised Least Squares (AR (1)); [p]=private; [s]=(former) state; [k]=OLS estimate unless otherwise specified; t=ratio (from zero) at 5 per cent significance level in parentheses

[Source: Boyd (1988, 1991) and Florkowski, Hill and Zareba (1988)]

477 MAF, 1994.

478 Despite the notable similarities with Boyd's study, definitions of the dependent and independent variables included in each model differ marginally. These include: output is gross agricultural production in 1977 prices (total crop production plus a livestock index); quality-adjusted labour and land inputs and machinery was converted into horsepower (35 HP on average) (Boyd, 1988 and 1991; documented in section 4.2).

479 See section 4.2.

Alternative definitions of the 'land' variable (detailed in Appendix VIII) may have given rise to the disparity in the results of earlier Polish agricultural production studies. Boyd's (1988, 1991) private and (former) state land elasticity coefficients are 0.44 and 0.10 in contrast with 0.91 and 0.74 in this study (see Table 7.4 above). As for Florkowski, Hill and Zareba's work (1988), their private sector land elasticity estimate was 1.81 and their (former) state sector estimate was 0.003. However, the authors made no direct comments on either the coefficient or its insignificant t-ratio, choosing to focus on other variables used within the model instead. Nevertheless, the area of 'cultivated land' had the largest impact on both private and (former) state sector arable production during 1989-1993 and it is likely that cultivated land will continue to do so in the near future. This is substantiated by the magnitude of the private national and regional aggregate land elasticity coefficients (refer to Tables 7.1 and 7.2 above). Moreover, the successful disposal of (former) state owned agricultural land will result in further expansion and structural development of the private agricultural sector. Thus, agricultural land purchases will directly affect the overall agricultural structure and size distribution in the forthcoming period (Szemberg interview, 1994; and Portugal, 1995).

According to the Polish government's projections, profits arising from the present expansion of family holdings (purchasing[480] or renting[481]) will increase the future demand for land (MAF, 1994). Other research[482] carried out between 1988-1992 unearthed a process of polarisation in agricultural holdings. Whereas, smaller (< 5 hectares) and larger farms (>15 hectares)[483] increased in number, the ratio of middle-size acreage farms (5-7 hectares) marginally decreased (Szemberg 1992a; and Szemberg interview, 1994). While the process of land

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[480]The rate of land purchasing in the private sector is a response to a number of specific catalysts; the sale of (former) state owned land and its relation to the private farms (Portugal, 1995), the swift development of an efficient land market (Szemberg interview, 1994) and the present economic climate which includes for example, the costs of inputs, market prices of agricultural produce and the level of income.

[481] (i) In 1994, every fifth farmer rented 2-4 hectares and rented land accounted for 9-10 per cent of total farmers' land. However, this form of land use requires further development, more specifically in the granting of permanent tenancy. Under the Act of 29th December 1993, the Agricultural Property of the State Treasury (APA) has been authorised to contribute in the lease of agricultural assets (MAF, 1994).

(ii) Other research has shown that there has been an increase in the general popularity of leasing, particularly in the west, the north and the midwest (Szemberg, 1992a; Table VI.1, Appendix VI provides further information).

[482]Outlined in 7.1.

[483]Also already well-mechanised (Szemberg, 1992a).

concentration was more prominent in the western and northern regions[484], land deconcentration was more definite in the rest of the country.[485] Thus, the processes of land (de)concentration will result in an increase in both large and small agricultural holdings (Szemberg, 1992a). Land deconcentration is a new phenomenon directly related to economic transition. Its impact on the labour market will be all the more paramount as the number of part-time agricultural employees rises and rural structural unemployment increases[486] (Szemberg, 1992a).

During the next five years, private agricultural land owned by large farms (>10 hectares) is expected to increase from 45.4 (1994 figures) to 50 per cent (MAF, 1994) and the number of small farms (<5 hectares) is expected to rise from 18 to 25 per cent across all four regions (MAF, 1994). The majority of large holdings (>10 hectares) will survive economic transformation because of well geared investment[487] and relatively high product specialisation. Ancillary government organisations[488] have been established to develop managerial know-how, innovative and collusive behaviour in private sector farming (Szemberg, 1992c).[489] On the other hand, the smaller farms will have mainly labour-intensive production lines.[490] This is primarily because

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[484]Larger and bolder expansion plans (increases of 13-17 hectares) came from private farmers who are located in the regions where (former) state-sector farming was concentrated, such as in the North and West (Szemberg, 1992[a]). However, the fact that (former) state-sector property was distanced from private farms is hampering the effective transfer of ownership (Portugal, 1995).

[485]Of those farmers who were interviewed in Wagry and Rzgow during 1993 and 1994, most of the private farm enlargements were connected with family inheritance during the 1960s and 1970s. However during the year 1993/4, some of the richer private farmers had undertaken moderate expansions but there was little evidence of major restructure in these regions (Nowak interviews, 1993/4).

[486] (i) Rural unemployment is as high as 34 per cent in the northeast and northwest where (former) state-sector farming was predominantly located (Szemberg interview, 1994; Hypothesis 1, section 1.5; see also section 5.4.2).
(ii) Part 7.5 documents 'labour' in more detail.

[487]For example, investment in human capital may be manifested as active farmer participation in schemes which are set up at the Agricultural Centres around Poland, financed by the UK Know-How Fund (Hughes interview, 1994).

[488]For example, the 'Wrzenia' and 'Modiliszewice' are exchange programmes linked with Brankenhurst College, Nottinghamshire and are funded by the Agricultural Development Fund (1990) (UK, Know-How Fund). The projects focus on training, education and 'commercialisation' (sharing of machinery). The Agency of Restructuring and Modernisation of Agriculture (ARMA) programme was initiated in March 1994 and jointly funded by The World Bank and the National Bank of Poland. It concentrates on financial aspects, such as the provison of cheap credit facilities. Struder (PHARE funded) was initiated in December 1992 to focus on business strategies and training specifically in voivodships (counties) experiencing acute rural unemployment (Hughes, Santorum and Smith interviews, 1994; documented in section 2.5.4).

[489]For example, promotion in the use of new technologies (e.g, new breeds) and the encouragement of downstream vertical integration with food processing industries (MAF, 1994; Hughes and Smith interviews, 1994).

[490]These include vegetables, special cultivations, greenhouses, poultry, egg farms and bee-keeping (MAF, 1994).

demographic and economic factors restrict the mobility of the rural labour force (Szemberg interview, 1994).

Although land concentration began in the early 1980s, agricultural structural improvement ceased after 1989 in response to a combination of factors. These have been cited as 'the lack of funds for development'[491], barriers to investment[492] and private farmers 'waiting for a change in the present government's agricultural pricing policy'.[493] More specifically, the private farmers expect alleviation (such as subsidies) from the government in their cost-price squeeze[494] (Ash, 1992; Szemberg, 1992a; and Szemberg interview, 1994). Perhaps this is evidence of the 'behavioural overhang' from the 'Communist' era, as identified in section 1.3). Most private Polish farmers in 1994-5 seemed to have this misplaced belief in both the present Polish government's willingness and ability to provide economic assistance as experienced in the mid-eighties (Klodzinski, 1992; see section 2.4). In fact, the Polish government was severely constrained by the lack of available funds between 1990 to 1995[495] (Wos and Borek interviews, 1993/4).

The successful redistribution and restructuring of (former) state owned property, although hampered by huge debts[496], remains an important facet in the process of economic transformation

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[491]Hyperinflation during 1990/1 resulted in the average agricultural wage being 60 per cent of the average industrial wage (GUS, 1993b). The prevailing high interest rates (45 per cent in 1995) coupled with the private sector viewed as a 'liability' by the financial institutions (Perotti, 1993) have only contributed to dampening the rate of rural investment in the early transition period. Thus, the likelihood of farmers being able to allocate resources for development have and are severely hindered (Szemberg, 1992d).

[492](Former) employees of the liquidated State agricultural enterprises or employee partnerships have had priority over the distribution of former state owned land (APA, 1994: 9; Table VI.2, Appendix VI provides further documentation).

[493]Szemberg, 1992c; Ash, 1992; and Anuszewski, Borek, Choynowoki, Kisiel, Santorum and Szemberg interviews, 1993/4.

[494]Economic transformation began in 1989 resulted in a cost-price squeeze for the rural population. Hyperinflation meant substantial increases in the costs of the means of production (documented in section 2.5.1).

[495]The growing burden of debt servicing (18-22 per cent of budget income), expenditures on social securities (about 20 per cent) and the International Monetary Fund budget plans have impeded any substantial increases in government budgetary funds allocated to agriculture (MAF, 1994; see section 2.5.4).

[496]A combination of poor management, lack of internal and external competition, guaranteed sale of produce and meeting quotas instead of profit maximisation, (former) state-owned farms in real terms had been running at a loss for some time prior to economic reform in 1989. Hence, in 1989, when reform plans were initiated, the state sector was already heavy in debt (Pacione, 1986, Klodzinski, 1992, Ash, 1992, Balcerowicz, 1993). By the end of 1993, the Agency's debts had risen to the level of 16 830 billion zloty. The debts exceed the value of the property itself (APA, 1994; refer to sections 2.5.3 and 5.5.2.1).

and private sector agricultural expansion.[497] At present, its disposal falls into three categories. Marginal farm land is being taken out of production, set-aside for non-agricultural purposes and the remainder is either sold or leased. Over 100,000 hectares have been designated for infrastructure[498] (until 2000) and 230,000 hectares will mainly be afforested[499] in the form of private woods, including agro-forest holdings (Wos and Bialobrzycki interviews, 1993/4). Land intensification will gain momentum after 1997[500] to improve the quality of Polish soils.[501] Despite the introduction of legal regulations[502] in 1994, nevertheless the exclusion of poor quality land from agricultural use may prove difficult and costly to implement and monitor. The long-term environmental costs for the process of agricultural intensification have been soil erosion (over-use of fertilisers, herbicides and insecticides), river/water pollution (run-off from the crops) and a decline in the long-term potential land production.[503]

The APA[504] (under the Act 29th December 1993) was established to accelerate the sale or lease of (former) state sector property. It's aims include increasing the number of persons

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[497]Ash, 1992; Klodzinski, 1992; Borek interview, 1994; MAF, 1994; and Portugal, 1995.

[498]This will absorb some of the excess labour and hidden rural unemployment which is cited as being one of the major barriers for the restructuring of polish agriculture (Sikorska, 1992; Borek, Kwiecinski, Kisiel, Nowak, Szemberg and Wos interviews, 1993/4; and MAF, 1994).

[499]If the process will last till 2015, then the share of forests in the total area of the country will increase to 30 per cent and will approach the level characteristic for other European countries. For example, 5.8 million hectares are devoted to forestry in the UK (MAF, 1994).

[500]It is envisaged that by 2000, farm land resources will have decreased by about 1.8 per cent (up to 18.3 million hectares) (MAF 1994).

[501]The improvement of soil quality structure is likely to be slow; the share of highest quality soils is expected to increase by a mere 0.7 per cent by 2000. By 2015, soils classified as the highest and good quality (Class I, II, IIIa (defined in section 5.3) will increase by a further 2.5 per cent to
the level of 57 per cent (MAF, 1994).

[502]Draft Law on Protection of Farm and Woodland which the government submitted to the Sejm in 1994. The Law includes compensation for agricultural damages due to environmental pollution, contamination and other forms of soil degradation (MAF, 1994).

[503]Costs which have been borne by highly developed farming in the industrialised nations.

[504]Defined in 2.5.3.

authorised to purchase flats[505]; clear definition of ownership rights[506] and the encouragement of prospective buyers and tenants via incentives.[507] Despite these efforts, only 6 per cent of all former state owned assets had been sold outright or given away free of charge, 41 per cent actually leased to private farmers by the end of July 1994 and 53 per cent remained in the stock (APA, 1994: 2; and Portugal, 1995; see Table VI.1, Appendix VI). These remaining fixed assets are likely to be developed by the Agency companies under the administration of managers selected on the basis of competition (MAF, 1994). However, the transfer of 'ownership' per se is insufficient in itself to result in highly specialised, cost-effective productive units. It is vital to ensure that the administrators/managers who have and are acquiring (former) state owned property possess the managerial know-how to transform these farms into successive businesses (van Zon, 1992; and APA, 1994). It has been anticipated that by 2000, there will be 4-5 thousand large holdings[508], mainly hired labour[509], covering approximately 16 per cent of (former) state owned land (MAF, 1994).

Prior to economic transition, 2 per cent of agricultural land had been owned by the (former) state sector in the voivodship (county) of Lodz, a further 1-1.5 per cent was co-operative and the remainder was privately owned in 1989. At the time of the first phase of interviewing in summer 1993, the Regional Agricultural Property Agency had successively rented or sold 50 per cent of (former) state owned land but by the end of 1993, this figure had risen to 64 per cent (Choynowoki interview, 1993; and APA, 1994). In 1992, the only (former) state sector farm (360 hectares) in Wagry was sold to two private farmers. The farm now produces vodka and cereals which are sold on in the nearby city of Koluscie. Whereas there were 25 permanent workers resident at the farm when it was under state control, there are now only 13 who reside in the surrounding villages. There is an additional seasonal workforce of 47. (Former) state owned

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[505]The APA took control of a quarter of a million of flats between 1990-1993 (APA Report,1994).

[506]The establishment of private property rights is crucial to agricultural development. The waiting time of several months to establish or transfer the ownership title, to establish the land register, and to determine the size or location of the plot have rendered trading in agricultural real estate difficult (APA, 1994).

[507]The contracted debt can be repaid in instalments over a ten year period with low interest rates on the credit (0.25 of the refinancing credit) (MAF, 1994).

[508]Ranging between 100-1000 hectares in size (MAF, 1994).

[509]Fixed-rent contracts are replacing fixed-wage contracts, partially alleviating the problem of acute rural unemployment (MAF, 1994).

capital[510] is now also privately owned (Nowak interview, 1994).

Land is and will remain at least in the short term, the most significant of the conventional independent variables in Polish arable production. The 'consolidation of plots' in the private sector and the redistribution of (former) state sector property will ultimately advance the development cycle, especially for the already existing larger private farms (>7 hectares). Thus, based upon Cornia's results and conclusions (1985), the magnitude of the national aggregate land elasticity coefficient generated by the Polish agricultural private sector is likely to decline in the long-term. The future for the middle-income farms is particularly unstable as it is unlikely that they will be unable to compete in the market (Wos interview, 1994). The long-term trade-off for private Polish agriculture will include the loss of approximately 1.5 million farms. Thus, the net result is likely to be an increase in structural unemployment, precipitated by the creation of a short-term rural labour surplus and inadequate work opportunities for the displaced labour (Borek, Kwiecinski and Szemberg interviews, 1993/4; refer to section 7.5.3).

The following part focuses on 'capital', the second most influential independent variable on Polish arable production during 1989-1993. Its structure is similar to the analysis of 'land' in that it divides into three main sections. The first presents the aggregate capital elasticity coefficients of this study, the second summarises the capital elasticity estimate derived in earlier general farming production analyses, while the third focuses on Polish agricultural production studies closing Part 7.3 with present Polish government policy on capital inventories till the year 2000.

7.3 Operative Capital

7.3.1 The aggregate operative capital elasticity coefficient

Table 7.5: Aggregate Operative Capital elasticity coefficients of Polish farming, 1989-1993

	Total	NW	NE	SE	SW
Private	0.172 (4.335)	0.141	0.339 (1.494)	0.528 (4.816)	0.242 (0.701)
State	0.420 (7.447)	0.583 (3.819)	0.247 (0.769)	0.360 (3.203)	0.414 (4.978)

t-ratios (from zero) at five per cent significance level in parentheses

[Source: Compiled by Author]

[510]Which included 3 light tractors (15/20 years old) and 2 combine harvesters (Nowak interview, 1994).

Tables 7.1 (Part 7.1) and 7.5 display both national and regional aggregate capital elasticity parameters generated by the Polish primary sector. Significant private and (former) state sector t-ratios at the five per cent level indicate that 'tractor usage' was instrumental to national private and (former) state arable production during this period such that a 1 per cent increase in capital implies a 0.17 and a 0.42 per cent rise in its production capacity respectively. The comparative magnitudes of the aggregate capital elasticity estimates generated in each region illustrate spatial agricultural diversification.[511] However, the lowest private sector aggregate capital elasticity coefficient occured in the northwest (0.141), contesting Hypothesis 7 (section 1.5 and 7.1). Other empirical research[512] found a higher level of private sector demand for other machines than tractors in this region.[513] During 1988-1992, the northwest focused on increasing its present level of inventories to meet Western European standards (Szemberg, 1992c). The t-ratio of the north eastern aggregate capital elasticity estimate is low (1.494) which is also congruous with the same empirical study[514], as it found a higher level of private sector demand for other machinery in this area too (Szemberg, 1992c). Heavy capital investment in the northeast was in response to the current poor technical equipment. However the southwest's low aggregate capital elasticity coefficient (0.242) together with its low capital t-ratio (0.701) reveals 'operative tractors' had a limited effect on private arable production levels in this region. Additional empirical research[515] has found the lowest capital investment activity[516] was in the southwest (37-42 per cent)[517] which was in response to unfavourable economic conditions[518] and a high concentration of emigration

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[511]Presented in 1.5, 5.4.2 and 7.1.

[512]Op cit.

[513]Whilst 23 per cent of the investment outlay occurred in machines, only 19 per cent of the investment outlay went to tractors in the mid-west and north during 1988-1992 (Szemberg, 1992c: 28).

[514]Detailed in 7.1.

[515]Op cit.

[516]This includes investment in farm buildings, all machines, tractive force basic herd and farmland (Szemberg, 1992c).

[517]In contrast with the northwest (> 60 per cent) and northeast (55 per cent) (Szemberg, 1992c).

[518]Associated with economic transition.

to Germany.[519] In comparison, an insignificant[520] (former) state capital t-ratio indicates 'tractor usage' was negligible in north eastern (former) socialised arable production. This was because one of the highest depletion of capital stock occurred in the northeast (detailed in section 5.4.2 and Table V.2, Appendix V) and because farming in this area was the least capital-intensive of all state quarters.[521] Notably, the northwest (0.583) generated a (former) state aggregate capital elasticity coefficient of the highest magnitude simply because (former) state farms were concentrated in this region[522] (Dawson, 1982 and Szemberg, 1992a). The sole reason for the decline in (former) state-owned capital stock is the privatisation of state-owned industries.

The next section analyses the national aggregate capital elasticity estimates generated by each sector of Polish farming within the context of earlier cross-country, (former) socialist or national agricultural production studies. Whilst the first objective is a feasibility test, the second is to ascertain the stage(s) of agricultural development which both farming sectors have reached using the national aggregate capital elasticity estimates.

7.3.2 Earlier agricultural production studies: the 'capital' elasticity coefficient

Table 7.6 below documents the aggregate capital elasticity estimates generated in earlier world studies; Appendix VIII details the exact definitions of the independent and dependent variables used in each agricultural model.

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[519]Over the period 1988-1992, rural emigration from the voivodships (counties) of Opole and Katowice represented over half of overall emigration from rural areas of Poland (Szemberg, 1992d; refer to section 7.5.1).

[520]At the five per cent level.

[521]Evident from the capital/labour ratios in Table V.2, Appendix V; and the relative magnitudes of the capital and labour elasticity coefficients (presented in Tables 6.7 and 7.1).

[522]See 7.1 and 1.5.

Table 7.6: Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Capital elasticity coefficient[k]	
	Cross-country studies						
Bhattacharjee (1955)	CD[a]	OLS[c]	Industrialised and LDCs	22	1952	0.03 (0.22)	
Hayami and Ruttan (1971, 1985)	CD	OLS	Industrialised and LDCs	38	1955 1960 1965	0.12 (1.93)	
Evenson and Kislev (1975)	CD	OLS	Industrialised and LDCs	36	1950 1960 1965 1968	0.15 (2.50)	
Nguyen (1979)	CD	OLS	Industrialised and LDCS	40	1955 1960 1965 1970 1975	0.31 (3.78)	
Yamada and Ruttan (1980)	CD	OLS	Industrialised and LDCs	42	1970	0.11 (1.71)	
	LDC subsample						
Antle (1983)	CD	OLS, PCR[d]	Industrialised[g] and LDCs[f]	66	1965	n.a.	
Kawagoe, Hayami and Ruttan (1985)	CD	OLS, PCR	Industrialised[g] and LDCs	43	1960 1970 1980	0.18[g] (3.24)	0.14[f] (2.57)
Lau and Yotopoulos (1968)	CD, TL[b]	OLS	Industrialised[g] and LDCs[f]	43	1960 1970 1980	0.07[g] (1.37)	0.06[f] (1.94)
Yotopoulos (1968)	CD	OLS	Epirus, Greece	1	1964	0.06 (0.02)	

Table 7.6 (contd): Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Capital elasticity coefficient[k]
	Studies of Socialist farming					
Wong (1986)	CD	PCR	Socialist	9	1959-1979	0.05 (2.62)
Wong & Ruttan (1983)	CD	PCR	Socialist	8	1959-1979	0.05 (2.84)
Clayton (1980)	CD	OLS	Soviet Union	1	1960-1975	0.14 (2.33)
Brooks (1983)	CD	PCR	Soviet Union, US, Canada, Finland	4	1960-1979	-0.04 (-0.98)
	Studies of Transitional Agriculture					
Johnson et al. (1994)	CD	ML[h]	Ukraine	1	1986-1991	n.a.
Fleisher and Liu (1992)	CD	OLS	Transition Economy-China	1	1987-1988	0.06 (3.57)
Lin (1989)	CD	n.a.	Transition Economy-China	1	n.a.	0.06
Screene	CD	GLS[e]	Poland	1	1989-1993	0.172[p] 0.420[s] (4.335) (7.447)

[a]=Cobb Douglas; [b]=Translog Production function; [c]=Ordinary Least Squares; [d]=Principle Components Regression; [e]=Generalised Least Squares (AR (1));[f]= LDC subsample; [g]=Industrialised subsample; [h]=Maximum Likelihood; [j]=Appendix VIII provides further details; [p]=private [s]=(former) state; n.a. denotes not available; [k]=OLS estimate unless otherwise specified; t-ratios (from zero) at five per cent significance level in parentheses

[Source: Yotopoulos (1968); Clayton (1980); Wong (1986); Trueblood (1989); Fleisher and Liu (1992); and Johnson et al. (1994)]

As discussed in Part 7.2 and in Chapter 3, an underlying theoretical assumption of the Cobb Douglas production model is that inputs are homogeneous. In practice, incomplete, inaccurate or unavailable data sets are likely to have determined the alternative 'capital' definitions used by each author in their analyses. Thus capital elasticity estimates may be purely indicative, generated haphazardly by each model (see also Appendix VIII). Nevertheless, the magnitudes of the aggregate capital estimates will provide insights into Polish socio-economic agricultural development. As represented in Table 7.6, the private national aggregate capital elasticity coefficient during the period 1989-1993 was 0.17, falling within the range of parameters defined in earlier agricultural production studies (0.31 and -0.04).[523] However, as it falls outside of the LDC range of parameters (0.06-0.14), the results challenge Hypothesis 3 (section 1.5). The (former) state sector estimate (0.42) exceeds estimates across all groups of studies.

Generally speaking, the magnitude of the capital elasticity estimates generated by LDCs is lower than those produced by industrialised countries, simply because agriculture in developing countries is less capital and more land-intensive (Cornia, 1985; and Trueblood, 1989). For example, in Cornia's cross-sectional study of fifteen LDCs[524] in 1970, the capital elasticity coefficients oscillated around 0.10-0.20[525] often with insignificant t-ratios (Cornia, 1985). Other research by Lau and Yotopoulos (1968), Yotopoulos (1968)[526], Kawagoe, Hayami and Ruttan (1985), Lin (1989) and Fleisher and Liu (1992)[527] all generated a low capital elasticity coefficient in their agricultural production studies implying an earlier stage of agricultural development (shown in Tables 1.1 and 7.6). Indeed, a private Polish aggregate capital elasticity estimate (0.17) implies farming is as least as capital-intensive as LDCs.[528]

The magnitude of the (former) Polish state sector aggregate capital estimate (0.42) is larger than the estimates derived in socialist studies (-0.04-0.14) by Clayton (1980), Brooks (1983), Wong and Ruttan (1985) and Wong (1986) despite economic transformation[529] (refer to Tables 1.1 and 7.6 above). Another important aspect to consider is the heterogeneity in the

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[523]Yotopoulos, 1968; Clayton, 1980; Wong, 1986; Trueblood, 1989; Fleisher and Liu, 1992; and Johnson et al., 1994.

[524]These countries included Barbados, Mexico, Peru, Ethiopia, Nigeria, Uganda, Tanzania, Sudan, Syria, Bangladesh, Burma, India, Nepal, Korea and Thailand (Cornia, 1985).

[525]However, there were two exceptions: Thailand (-0.03) and Burma (0.38), of which the author offered no explanation (Cornia, 1985).

[526]A priori expectations of Greek agriculture being characteristically labour-intensive meant that a low capital estimate was no surprise to the author. However, an additional factor to depress 'tractor usage' would have been the mountainous terrain characteristic in Epirus (Yotopoulos, 1968).

[527]Whereas land may have depressed the demand for tractive force in Epirus, the size of plots may have had the same result in China. The average size of Chinese farming plots was 0.27 hectares in 1987-1988 and each family had less than 1 hectare in total. Thus, there is a possibility that size may have reduced the demand for tractive force and the incentive to invest causing the capital elasticity coefficient to decline (Fleisher and Liu, 1992).

[528]Despite the reform in polish agricultural policy in the late 1980s when heavy capital investment ensued (detailed in section 2.4).

[529]Privatisation of former state owned farms resulted in the sale of capital stock (Szemberg, 1992c). Moreover, the trend in former state-owned capital has been declining over the period 1990-1993 (refer to section 5.4.2 and Table V.2, Appendix V).

(former) socialist agricultural systems.[530]

The subsequent section refers to previous agricultural production studies which focused explicitly upon Poland. As before, the analysis concludes by looking ahead towards the year 2000 evaluating the prospects for capital in the Polish primary sector.

7.3.3 Polish agricultural production studies: 'the capital' elasticity coefficient

Table 7.7 below summarises the aggregate capital elasticity estimates created by each Polish agricultural sector within past Polish agricultural production studies. These studies include those by Boyd (1988, 1991) and Florkowski, Hill and Zareba (1988).

Table 7.7: Features of Polish Agricultural Production Functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Capital elasticity coefficient[f]	
Boyd (1988, 1991)	CD[a]	IV[b]	Poland	1	1960-1982	0.02[e] (2.75)	
Florkowski, Hill and Zareba (1988)	CD	3SLS[c]	Poland	1	1956-1983	0.09[p] (1.68)	0.23[s] (1.50)
Screene	CD	GLS[d]	Poland	1	1989-1993	0.172[p] (4.335)	0.420[s] (7.447)

[a]=Cobb Douglas; [b]=Instrumental Variable Function; [c]=Three Stage Least Squares; [d]=Generalised Least Squares (AR (1)); [e]=combined data for private and state; [f]=OLS estimate unless otherwise specified; j=Appendix VIII provides further details; [p]=private; [s]=(former) state; t-ratio (from zero) at five per cent significance level in parentheses

[Source: Boyd (1988, 1991) and Florkowski, Hill and Zareba (1988)]

In common with studies already considered in this chapter, the range of 'capital' definitions used by the authors, the diversity in model specifications and the different time periods under analysis mean it is especially difficult to make any comparisons between sets of results (see Appendix VIII). In the first instance, Boyd combined private and state data sets to generate one capital elasticity coefficient eliminating any differentiation in ownership. On the other hand, Florkowski, Hill and Zareba (1988) derived a private and (former) state sector capital elasticity estimate of 0.09 and 0.23 respectively, albeit with low t-ratios. One can only conclude that a high

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[530]For example, the average size of (former) state-owned farms in Poland are 10 times smaller than those in Hungary or the FSU (Borek interview, 1994) thus varying capital/land intensities would have affected the magnitude of the elasticity coefficients respectively.

aggregate capital elasticity coefficient (0.17) derived in the present study, perhaps suggests the private Polish farming sector has become more capital-intensive since the early 1980s. In fact, government agricultural policy during this decade was modified so as to recognise the superior performance of the private sector.[531] Similarly, the national (former) state sector capital estimate (0.420) is significantly higher than that of Boyd (0.02) or that of Florkowski, Hill and Zareba (0.23) despite state sector privatisation[532], depletion of (former) state-owned capital stock and the withdrawal of government subsidies since 1990 (Ash, 1992; see also 6.5). As for ascertaining the exact stage(s) of agricultural development within Polish farming, in common with previous discussion, the results suggest private farming is more land-intensive and less capital-intensive than (former) state farming. Therefore, both independent variables imply the private sector is at an earlier stage of agricultural development (confirming Hypotheses 2 and 3, section 1.5).

During the early transition period, the number of tractors operating in private farming began to stabilise across all four regions of Poland.[533] More importantly, the average size of a farm equipped with a tractor decreased from 11 to 9 hectares, which indicates Polish peasant farming is in it's final stage of tractorisation (Szemberg, 1992c). Whereas smaller farms (< 5 hectares) bought second hand tractors as their first purchases, larger farms (>15 hectares) were able to invest in new heavy duty, expensive machines (Szemberg, 1992c). However, 31 per cent[534] of the total value of technical means was concentrated in 12.5 per cent of farms from the largest group (>15 hectares).[535] At the time of interviewing,[536] 23 per cent of farmers intended to buy machines[537] between 1992-1996 and half of this 23 per cent were already affluent, well-equipped

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[531]The government amended the Constitution to guarantee the permanence of private farm ownership. As a result, heavy capital investment in the private sector followed (Agra Europe Special Report No. 56, 1990; Klodzinski, 1992; and Ash, 1992; refer to section 2.4).

[532]See Part 7.2.

[533]There were approximately 1, 050 thousand pieces in operation in Poland in 1993 (detailed in section 5.5.3.1 and Table V.1, Appendix V).

[534]29 per cent in 1989 (Szemberg, 1992c).

[535]This trend was consistent across the whole of Poland, except the southeast, which incidentally has the smallest farm sizes (Szemberg, 1992c; see section 5.4.2).

[536]Detailed in 7.1.

[537]The highest demand for machinery from the farmers, over the period 1992-1996, included combine harvesters (3 per cent), machines for basic cultivation (4 per cent) and machines for picking up and drying of green fodder (4 per cent) (Szemberg, 1992c).

and representative of the large farm size group (>15 hectares). Thus, the process of polarisation in agricultural holdings[538] has been characterised with capital investment consolidated in the larger-sized private farms (Szemberg, 1992c).

The stabilisation of tractive force across the whole of Poland is in response to four specific factors. First, the winding up of sales in (former) state-operated farms and agricultural co-operatives. Second, individual private farmers, who are liquidating their farms (although marginal) and switching to non-farming activity, are releasing second-hand machinery. Third, saturation in the market and fourth, a direct response to the substantial price rises in capital inventories since 1989.[539] Many farmers who were unable to purchase new machines, either invested in second-hand ones, repaired existing machines[540], undertook joint investment with other farmers [541] or foreign investment (more likely in the north and southwest), rented from the larger farms nearby, applied to ARMA for financial help (cheap credits) or purchased (former) state sector property at cheap rates.[542] Of those farmers who were interviewed in Wagry and Rzgow, attempts at cooperative schemes failed:

> "..In the past, the farmers had formed a cooperative and shared or hired the machinery. Now, there are only private companies which sell services and charge 2-300 000 zlotys per hour to hire.." (Farmer interview, Wagry, 1993).

> "(There is)..no change to the level of inventories and the old machinery is still in operation. The local community tried to organise a communal institution to share machinery, but it did not work. Farmers like to stay on their own. The relationship is more like friends than business or the state organisation.." (Nowak interview,

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[538]See 7.2.3.

[539]The average prices of agricultural products rose by 253 per cent during 1989 (Szemberg, 1992c).

[540]In areas of Wagry and Rzgow, the second hand tractor is still the favoured type of machinery:

> "..(we have) 1 tractor which is 12 years old and is second hand. It breaks down twice a year because there is a problem with the wheel. (we must) fix it ourselves since a good model is very expensive to repair.." (Farmer interview, Wagry 1993).

> "..In 1992, we were unable to pay for repairs and so had to repair our own tractor and baler but the spare parts are very expensive.." (Farmer interview, Rzgow 1993).

> "..All our capital is second hand. We own all our equipment, since we can't afford brand new tractors simply because we cannot afford loan repayments.." (Farmer interview, Rzgow, 1993).

[541]Survey results reveal that 1 in 9 farmers undertake joint capital investment with neighbours when the prices of machinery are high (Szemberg, 1992c). This is likely to increase substantially in the future.

[542]Szemberg, 1992c; Santorum interview 1994; and MAF, 1994.

1994).

> "..The farmers can rent the combine-harvester from the farmer who has the largest farm (exceeds 30 hectares), when it comes to harvest times. However, we are completely reliant on him for resources.." (Farmer interview, Rzgow, 1994).

Although such schemes have proved unsuccessful so far, any attempts at cooperative activity manifests an increasing appreciation of the need to reduce mechanisation costs.[543] Moreover, the rise in private farmer's ability to formulate business plans[544] coupled with a number of government funded programmes[545] both confirm the shift to 'commercialisation' is under way (Hughes and Smith interviews, 1994).

Whilst 'operative capital' remained an important variable in private Polish arable production during the early transitional years, the volume of purchases of tractors is expected to decline (4 times) by 2000 mainly due to saturation in the market[546] (Szemberg, 1992c). Thus, one would expect the magnitude of the private sector aggregate capital elasticity coefficients to remain virtually unchanged in the near future.[547] At this time, the owners of tractors purchased in the years 1974-1980 will begin exchanging them for new machines[548] and the sales of tractors will again rise. According to one Polish government report, the demand for machines and equipment related to animal production will be much higher than for other product groups (MAF, 1994). However, other research[549] has shown that farmers attitudes towards farm modernisation for animal breeding were definitely negative and their interest in livestock breeding fell significantly

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[543]Perhaps this is evidence of positive behavioural change in the private farmer approach and a shift away from the Communist ideology that gripped the farmers in the past, identified in section 1.3.

[544]For example, reduction in fixed and variable costs, profit maximising behaviour, product specialisation, collusive behaviour, increasing awareness of research and education or expansion in farm size for economies of scale and scope (see Appendix IV).

[545]These schemes include the UK Know-How Fund and the Poland and Hungary Assistance for the Reconstruction of the Economy (PHARE) (EU) programmes which educate and assist farmers to organise their farms into productive units (refer to section 2.5).

[546]Only 5 per cent of farmers surveyed in 1992 expressed an interest in purchasing tractors (Szemberg, 1992c).

[547]This assumes that capital' is defined as 'operative tractive force'. However, as the demand for other capital inventories (such as combine harvesters) increases, a variable that includes all farming machinery would prove more appropriate for future analysis, as long as the data exists.

[548]This is based upon the assumptions that these farmers have remained in agriculture and that the cost of capital depreciation is accounted for.

[549]Detailed in Part 7.1.

during 1989-1992[550] (Szemberg, 1992c). In fact, the premature slaughtering of animals substantially reduced the level of animal stock and damaged lifecycles; the net effects were manifested as a decrease in the supply of meat[551], milk and home-produced fertilisers together with a reduction in the demand for feedingstuffs. The decline in livestock production[552] has been cited as being one of the major tradeoffs of economic transition (Reed and Wos interviews, 1993/4).

As for the socialised sector of Polish farming, 'During 1989-1992, the trend was to get rid of machines' (Szemberg, 1992c: 4) primarily to combat the rising debts[553] and the release of over capital investment which had taken place in the previous decade (APA, 1994). However, the transfer of central to private control was and is fraught with instability and time lags in the implementation of the legal framework. Whilst these proceedings were taking place, the APA was unable to simultaneously conduct ownership transfers and retain previous levels of production. At the same time, Poland was experiencing a period of hyperinflation compounding the (former) state sector debt crises into an even deeper and more critical position (APA, 1994; detailed in 2.5.3, 5.5.1.1 and 7.2.3). The prevailing downward trend in (former) state-owned operative capital[554] is expected to continue in the future. The release of capital may marginally improve prospects for private sector farming but already saturation in the private sector market may result in tractors left idle or abandoned. Of the private farmers that do invest in (former) state-owned machinery, its quality is likely to be better despite them being second-hand (Szemberg interview, 1994).

The subsequent part considers 'fertiliser', the third most instrumental conventional independent variable on Polish harvest yields during early economic transformation. Its structure corresponds with the preceding analyses of 'land' and 'capital' in that it divides into three main

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[550]Between 1988-1992 the share of farms without cattle rose from 14 to 20 per cent, without cows-from 16 to 22 per cent, without pigs-from 18 to 24 per cent and farms without livestock from 6 to 11 per cent. Decrease was noted in the shares of producers supplying to the market the following products: milk from 77 to 61 per cent; cattle from 84 to 73 per cent, poultry from 12 to 8 per cent and pigs from 70 to 68 per cent (Szemberg, 1992c).

[551]Documented in section 2.5.1.

[552]Op cit.

[553]Detailed in 7.2.3, 2.5.3 and 5.5.1.1.

[554]See Table V.2, Appendix V.

sections. The first details the aggregate fertiliser elasticity parameters of this study, the second reviews the fertiliser elasticity estimates generated in previous general farming production investigations, while the third centres on Polish agricultural production studies closing Part 7.4 with an assessment of future trends in the demand and supply of chemical and lime fertilisers till the year 2000.

7.4 Fertiliser Usage

7.4.1 The aggregate 'fertiliser' elasticity coefficient

Table 7.8: Aggregate Fertiliser elasticity coefficients of Polish farming, 1989-1993

	Total	NW	NE	SE	SW
Private	0.107 (6.964)	0.166	-0.028 (-0.155)	0.205	0.181 (5.940)
State	0.160	0.427 (7.300)	0.271 (0.917)	0.040	0.272 (1.307)

t-ratio (from zero) at 5 per cent significance level in parentheses

[Source: Compiled by Author]

Tables 7.1 (Part 7.1) and 7.8 present both national and regional aggregate fertiliser elasticity coefficients produced by each sector of Polish agriculture. Significant private and (former) state sector t-ratios at the five per cent level show fertiliser consumption affected national private and (former) socialised arable harvest yields during this period such that a 1 per cent increase in fertiliser usage would have led to a 0.11 and a 0.16 per cent rise in output respectively. The larger (former) state sector fertiliser elasticity estimate is due to the wider resource endowment[555] and heavy government subsidisation associated with central-planning (detailed in section 2.4). Once again, the comparative magnitudes of the aggregate fertiliser elasticity coefficients generated in each region reflect Polish agricultural diversification.[556] However, contrary to a priori expectations, the magnitude of the private north western estimate is lower than those parameters produced by the south western and north eastern regions, disputing Hypothesis 7 (section 1.5).

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[555]Detailed in 5.5.3.2 and 6.5.

[556]See sections 1.5, 5.4.2 and 7.1.

There are two explanations for these results. First, the re-direction of north western private sector investment expenditure into other factor resources, such as land, machinery (other than the tractors), farm buildings or livestock. Second, the small sample regional data distributions with a limited number of observations may have caused incorrect statistical estimation, ore more simply, inadequate data sources may have generated erroneous regressions (refer to Chapter 4, sections 5.4.2 and 6.5). The statistically insignificant aggregate fertiliser elasticity parameter of the private northeast (-0.155) substantiates the re-direction of farmer's investment towards machinery (detailed in section 7.3). In contrast, the aggregate private south eastern estimate (0.205) implies fertiliser consumption forms a substantial part of farming practices in this area. However, earlier analyses (carried out in Chapters 5 and 6) suggest the contrary.[557]

As anticipated, the north western region of (former) state-managed farming generated the highest aggregate fertiliser elasticity parameter of all four regions (0.427). Similarly, the eastern regions of the (former) state agricultural sector generated statistically insignificant parameters, which incidentally coincides with the highest falls in average fertiliser application per cultivated hectare (detailed in section 5.5.3.2).

The two following sections evaluate the national aggregate fertiliser elasticity estimates created by Polish farming within the context of earlier non-Polish and Polish agricultural production studies. The analysis is carried out in the same way as sections 7.2.2 and 7.3.2 in that the key objective is to establish how far each agricultural sector has reached in its agricultural development path. Part 7.4 concludes with a report on the forecasted trends in fertiliser production until 2000 evaluating the prospects for Polish farming.

7.4.2 Earlier agricultural production studies: the 'fertiliser' elasticity coefficient

Table 7.9 below presents the assortment of fertiliser elasticity estimates produced in earlier studies and Appendix VIII details the exact model specifications.

[557]This irregularity can be explained by considering the components of the aggregate estimate. As the DF slope differential parameter is positive and statistically significant, a specification error is likely to have occurred. Nevertheless, it has inflated the aggregate value and jeopardised accurate assessment of the fertiliser elasticity estimate associated with the southeast (see section 6.5).

Table 7.9: Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Fertiliser elasticity coefficient[k]
	Cross-country studies					
Bhattacharjee (1955)	CD[a]	OLS[c]	Industrialised and LDCs	22	1952	0.27 (2.57)
Hayami and Ruttan (1971, 1985)	CD	OLS	Industrialised and LDCs	38	1955 1960 1965	0.12 (1.95)
Evenson and Kislev (1975)	CD	OLS	Industrialised and LDCs	36	1950 1960 1965 1968	0.02 (0.36)
Nguyen (1979)	CD	OLS	Industrialised and LDCS	40	1955 1960 1965 1970 1975	0.02 (0.36)
Yamada and Ruttan (1980)	CD	OLS	Industrialised and LDCs	42	1970	0.24 (2.73)
	LDC subsample					
Antle (1983)	CD	OLS, PCR[d]	Industrialised[g] and LDCs[f]	66	1965	0.07[g] 0.14[f] (0.85) (1.88)
Kawagoe, Hayami and Ruttan (1985)	CD	OLS, PCR	Industrialised[g] and LDCs	43	1960 1970 1980	0.19[g] 0.09[f] (2.28)(1.56)
Lau and Yotopoulos (1968)	CD, TL[b]	OLS	Industrialised[g] and LDCs[f]	43	1960 1970 1980	0.10[g] 0.02[f] (1.24)(0.56)
Yotopoulos (1968)	CD	OLS	Epirus, Greece	1	1964	n.a.

Table 7.9 (contd): Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Fertiliser elasticity coefficient[k]
	Studies of Socialist farming					
Wong (1986)	CD	PCR	Socialist	9	1959-1979	0.22 (10.8)
Wong & Ruttan (1983)	CD	PCR	Socialist	8	1959-1979	0.21 (10.4)
Clayton (1980)	CD	OLS	Soviet Union	1	1960-1975	0.21 (7.0)
Brooks (1983)	CD	PCR	Soviet Union, US, Canada, Finland	4	1960-1979	0.30 (22.2)
	Studies of Transitional Agriculture					
Johnson et al. (1994)	CD	ML[h]	Ukraine	1	1986-1991	n.a.
Fleisher and Liu (1992)	CD	OLS	Transition Economy-China	1	1987-1988	0.09 (5.39)
Lin (1989)	CD	n.a.	Transition Economy-China	1	n.a.	0.06
Screene	CD	GLS[e]	Poland	1	1989-1993	0.172[p] 0.160[s] (4.335)

[a]=Cobb Douglas; [b]=Translog Production function; [c]=Ordinary Least Squares; [d]=Principle Components Regression; [e]=Generalised Least Squares (AR (1)); [f]=LDC subsample; [g]=Industrialised countries subsample; [h]=Maximum Likelihood; [j]=Appendix VIII provides further details; [p]=private [s]=(former) state; [k]=OLS estimate unless otherwise specified; t-ratio (from zero) at 5 per cent significance level in parentheses; n.a. denotes not available

[Source: Yotopoulos (1968); Clayton, (1980); Wong, (1986); Trueblood (1989); Fleisher and Liu (1992); and Johnson et al. (1994)]

Fertiliser application is used to measure the diffusion of biological/chemical innovation in the farming system. However, as there are many ways of estimating the role of manure within a model of agricultural production, the final estimates may be only partial indicators of technological advancement. Nevertheless, the magnitude of the aggregate fertiliser estimates generated by both sectors of Polish farming will help to verify their respective stages of agricultural development. As depicted in Table 7.9, the private and (former) state national aggregate fertiliser elasticity coefficients during the period 1989-1993 were 0.11 and 0.16, falling within the range of parameters defined generally by earlier agricultural production studies (0.02

and 0.30).[558] As anticipated, the private sector's fertiliser elasticity parameter is closer to those produced in earlier agricultural production studies of LDCs (0.02-0.14), confirming Hypothesis 4 (section 1.5). Similarly, the (former) socialised fertiliser elasticity coefficient is nearer to those generated by earlier agricultural production studies of socialist countries (0.21-0.30; see Tables 1.1 and 7.9 above).

Studies by Lau and Yotopoulos (1968), Kawagoe, Hayami and Ruttan (1985), and Fleisher and Liu (1992) have shown the magnitude of the fertiliser elasticity parameter and its t-ratio is generally[559] larger in the set of industrialised countries than the LDC subsample. There are three reasons why this is the case. First, fertiliser application is a function of the localised agricultural production procedures of less developed areas. Farming systems in the LDCs rely more heavily upon the relatively inexpensive factor resources (land and labour) than the relatively more expensive factors (such as capital or fertiliser) in the production process (Cornia, 1985; and Trueblood, 1989). Second, the magnitude of the fertiliser elasticity parameter is affected by the size distribution of farms and the organisational structure of the prevailing farming system. For example, small-scale, family or subsistence farms predominate the agricultural framework in LDCs. As such, they are far less likely to be exposed to the technologically more advanced agricultural practices used in large-scale, commercial farming.[560] As this is the case, technical diffusion and the transfer of knowledge from the large to the small farms simply does not happen. Therefore, technological inefficiency is a common occurrence in smaller farms. Third, research and the role of technical institutions also affect the pace at which newer farming techniques are developed and adopted. Earlier agricultural production studies of the industrialised and (former) socialist countries have generated high elasticity coefficients for fertiliser, education and research simultaneously (Trueblood, 1989). Therefore, the allocation of public resources (government expenditure) and the role of private institutions have an additional impact on the magnitude of the fertiliser elasticity parameter (refer to section 5.6.1).

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[558]See Table 7.9 above.

[559]One exception is Antle's study (1968) where the fertiliser elasticity produced by the LDC subsample (0.14) is larger than the industrialised set (0.07). However, his OLS results using the same data sets generated fertiliser elasticities of -0.01 and 0.05 respectively (Trueblood, 1989) complementing the research carried out by Lau and Yotopoulos (1968) and Kawagoe, Hayami and Ruttan (1985) (see Table 7.9 above).

[560]Such features include specialisation in production, intensification of capital inputs and integration of farm production with other parts of the total agricultural and food system (refer to section 2.2).

7.4.3 Polish agricultural production studies: the 'fertiliser' elasticity coefficient

Table 7.10: Features of Polish Agricultural Production Functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Fertiliser elasticity coefficient[f]	
Boyd (1988, 1991)	CD[a]	IV[b]	Poland	1	1960-1982	0.20[e] (21.58)	
Florkowski, Hill and Zareba (1988)	CD	3SLS[c]	Poland	1	1956-1983	0.28[p] (3.12)	0.40[s] (4.76)
Screene	CD	GLS[d]	Poland	1	1989-1993	0.107[p] (6.964)	0.160[s]

[a]=Cobb Douglas; [b]=Instrumental Variable Function; [c]=Three Stage Least Squares; [d]=Generalised Least Squares (AR (1)); [e]=combined data for private and state; [f]=OLS estimate unless otherwise specified; j=Appendix VIII provides further details; [p]=private; [s]=(former) state; t-ratio (from zero) at five per cent significance level in parentheses

[Source: Boyd (1988, 1991) and Florkowski, Hill and Zareba (1988)]

In Boyd's agricultural production analysis (1988, 1991), the fertiliser elasticity coefficient was 0.20 and its t-ratio was 21.58. On the other hand, Florkowski, Hill and Zareba (1988) generated a fertiliser elasticity estimate of 0.28 with a corresponding t-ratio of 3.12. Therefore, both these sets of regression results suggest the consumption of fertiliser used to have a more prominent role in Polish private arable harvest yields. As for the (former) state sector coefficient, its value is comparable with Boyd's (1988, 1991)[561] estimate, but half the magnitude of the fertiliser elasticity coefficient associated with Florkowski, Hill and Zareba (1988). The difference in magnitude is owing to both economic policy implications of early economic transition (see section 6.5) and the alternative variable(s) specification(s) adopted by each author (summarised in Appendix VIII).

There is little evidence of the present Polish government establishing an agricultural policy to help farmers expand their use of artificial or commercially produced fertilisers. The extent to which the government could offer financial assistance is related directly to the availability of funds, which is fairly unclear at this point in time. Nevertheless, the government predicts an annual average growth in fertiliser consumption of about 120 thousand tonnes by the year 2000. This is equivalent to approximately 900-1, 050 thousand tonnes of nitrogen[562] and about 500 thousand

[561] As Boyd (1988, 1991) combined information relating to fertiliser consumption in the private and (former) state sectors, it is irrational to draw any comparisons.

[562] Domestic national potential amounts to 1, 700 thousand tonnes per annum (MAF, 1994).

tonnes of phosphorus.[563] Expected demand for potassium imports amounts to around 700 thousand tonnes in terms of pure ingredients. As for calcium fertilisers, current soil acidity requires the spreading 4 million tonnes of calcium oxide (CaO) (215 kg per 1 hectare of arable land) per year (87 per cent higher than in 1993). However, the demand for calcium fertilisers will not require development of existing industrial and local mining potentials. Once again, the scale of soil liming growth will depend on the availability of state budgetary means (subsidies for production and transport of fertiliser calcium) (MAF, 1994).

The penultimate part of this chapter (Part 7.5) documents the labour elasticity coefficients. As in the preceding parts, it begins with an analysis of the national and regional aggregate labour elasticities generated by Polish farming during 1989-1993. Section 7.5.2 focuses on earlier non-Polish agricultural production studies while section 7.5.3 concentrates specifically on investigations of Polish farming production. This part culminates the analyses of the conventional independent variables with polish government labour policies until the year 2000.

7.5 Labour

7.5.1 The aggregate labour elasticity coefficient

Table 7.11: Aggregate Labour elasticity coefficients of Polish farming during 1989-1993

	Total	NW	NE	SE	SW
Private	0.106 (3.879)	1.128	0.602 (5.837)	-0.081	-0.198
State	0.081	-0.149	0.848 (5.185)	0.268 (1.847)	0.094

t-ratio (from zero) at five per cent significance level in parentheses

[Source: Compiled by Author]

Tables 7.1 (Part 7.1) and 7.11 summarise the aggregate labour[564] elasticity coefficients generated nationally and in each region by both sectors of Polish farming, reinforcing the existence of Polish spatial agricultural diversity.[565] The magnitude of this aggregate independent

[563]Domestic national potential amounts to 900 thousand tonnes (MAF, 1994).

[564]Section 5.5.4 provides a definition of the 'labour' variable.

[565]Detailed in 1.5, 5.4.1 and 7.1.

conventional variable nationally, suggests labour was the fourth[566] and fifth[567] most important factor in (former) socialised and privately produced harvests during the post-1989 period. In fact, a 1 per cent rise in employment would have raised national output by 0.08 per cent in the (former) state-managed farms and by 0.11 per cent in privately owned farms.

However, negative regional aggregate labour elasticity parameters of both the private southeast and southwest and the (former) state northwest imply the 'economically active farming population' may have actually reduced the agricultural capacity of each region by as much as 0.08, 0.20 and 0.15 per cent respectively. Rural overpopulation has been an intrinsic characteristic of the south eastern[568] region since the Austro-Hungarian empire[569] ruled between 1795 and 1918 (Dawson, 1982, see 2.4). The historical impact is still being felt even today and may at least, in part, be justification for the low aggregate labour elasticity coefficient of this zone (see also 6.5). In addition, the southeast has the highest agricultural population density of all four Polish regions and across the whole period (1988-1993)[570] which would have depressed the already low or negligible marginal productivities of labour during this investigative period (Szemberg, 1992d). Mass rural emigration from Opole and Katowice[571], a response to Polish economic transformation, is likely to have reduced the overall magnitude of the labour elasticity estimate generated in the southwest (-0.20). As for the northwestern (former) socialised sector, its labour coefficient is low because of surplus labour in the (former) state-run farms (detailed in 6.5).

In contrast, the positive aggregate labour elasticities[572] generated by the private regions of north Poland suggest a 1 per cent increase in the 'economically active rural population' is likely to have resulted in an average crop rise of 1.13 and 0.60 per cent. Despite what may appear to be favourable estimates for northern Poland, these areas have in fact been experiencing a much

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[566]After 'land', 'capital', and 'fertiliser' (see Parts 7.2, 7.3 and 7.4).

[567]After 'land', 'operative capital', 'fertiliser' and 'weather variation' (see Parts 7.2, 7.3, 7.4 and 7.6).

[568]Incidentally it is also a typically part-time farming region (Szemberg, 1992d).

[569]Another legacy from the Austro-Hungary empire was the diversification of private land into patchwork strips where small plots averaged 5.1 hectares (Dawson, 1982; refer to sections 2.4 and 5.4.2).

[570]Detailed in sections 5.4.2 and 6.5.

[571]Represented over half of overall emigration from rural areas of Poland (Szemberg, 1992d).

[572]Statistically significant at the five per cent level.

higher level of rural unemployment than the results indicate.[573] Introduction of private property rights and privatisation of (former) socialised farming sector[574] has resulted in extensive shedding of the labourforce (verifying Hypothesis 1, section 1.5). This is putting additional pressure on the already overburdened rural labour markets to such an extent that structural rural unemployment has been cited as one of the major barriers facing successive economic and social development in the Polish farming community (Szemberg, 1992d, Wos, Szemberg, Borek and Rowinski interviews 1993/4 and MAF, 1994; see section 6.5).

7.5.2 Earlier agricultural production studies: the 'labour' elasticity coefficient

Table 7.12[575] (below) documents the main features of previous cross-country and national agricultural production studies (see also Appendix VIII).

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[573]An accurate set of labour data which incorporates the mass urban-rural migration of bi-professionals would have generated much lower labour elasticity coefficients (Szemberg interview, 1994).

[574]See 5.4.2 and Table VI.2, Appendix VI.

[575]See also Table 1.1.

Table 7.12: Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Labour elasticity coefficient[k]	
	Cross-country studies						
Bhattacharjee (1955)	CD[a]	OLS[c]	Industrialised and LDCs	22	1952	0.30 (3.31)	
Hayami and Ruttan (1971, 1985)	CD	OLS	Industrialised and LDCs	38	1955 1960 1965	0.41 (5.51)	
Evenson and Kislev (1975)	CD	OLS	Industrialised and LDCs	36	1950 1960 1965 1968	0.44 (6.45)	
Nguyen (1979)	CD	OLS	Industrialised and LDCS	40	1955 1960 1965 1970 1975	0.37 (5.42)	
Yamada and Ruttan (1980)	CD	OLS	Industrialised and LDCs	42	1970	0.33 (3.61)	
	LDC subsample						
Antle (1983)	CD	OLS, PCR[d]	Industrialised[g] and LDCs[f]	66	1965	0.32[g] (3.30)	0.19[df] (3.92)
Kawagoe, Hayami and Ruttan (1985)	CD	OLS, PCR	Industrialised[g] and LDCs	43	1960 1970 1980	0.71[g] (8.62)	0.56[f] (5.46)
Lau and Yotopoulos (1968)	CD, TL[b]	OLS	Industrialised[g] and LDCs[f]	43	1960 1970 1980	0.32[g] (2.92)	0.33[f] (3.12)
Yotopoulos (1968)	CD	OLS	Epirus, Greece	1	1964	0.43 (0.07)	

Table 7.9 (contd): Features of studies that have estimated agricultural production functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Fertiliser elasticity coefficient[k]
	Studies of Socialist farming					
Wong (1986)	CD	PCR	Socialist	9	1959-1979	0.22 (21.6)
Wong & Ruttan (1983)	CD	PCR	Socialist	8	1959-1979	0.23 (22.5)
Clayton (1980)	CD	OLS	Soviet Union	1	1960-1975	0.37 (7.4)
Brooks (1983)	CD	PCR	Soviet Union, US, Canada, Finland	4	1960-1979	0.12 (5.74)
	Studies of Transitional Agriculture					
Johnson et al. (1994)	CD	ML[h]	Ukraine	1	1986-1991	0.056-0.406
Fleisher and Liu (1992)	CD	OLS	Transition Economy-China	1	1987-1988	0.20 (8.47)
Lin (1989)	CD	n.a.	Transition Economy-China	1	n.a.	0.21
Screene	CD	GLS[e]	Poland	1	1989-1993	0.106[p] 0.081[s] (3.879)

[a]=Cobb Douglas; [b]=Translog Production function; [c]=Ordinary Least Squares; [d]=Principle Components Regression; [e]=Generalised Least Squares (AR (1)); [f]=LDC subsample; [g]=Industrialised countries subsample; [h]=Maximum Likelihood; [j]=Appendix VIII provides further details; [p]=private [s]=(former) state; [k]=OLS estimate unless otherwise specified; t-ratio (from zero) at 5 per cent significance level in parentheses; n.a. denotes not available

[Source: Yotopoulos (1968); Clayton (1980); Wong (1986); Trueblood (1989); Fleisher and Liu (1992); and Johnson et al. (1994)]

The Polish private and (former) socialised aggregate labour elasticities (0.11 and 0.08) fall within the range of parameters derived internationally (0.71-0.06).[576] However, as the private sector estimate of 0.11 does not fall within the range specified by the LDC studies (0.19-0.56), this challenges Hypothesis 5 (section 1.5). In fact, the private sector labour estimate is closest to the labour parameter of Brooks' (1983) time series study contrasting Soviet agriculture with industrialised farming (0.12).

As anticipated, the magnitude of the (former) state sector's aggregate labour elasticity

[576]Bhattacharjee, 1955; Lau and Yotopoulos, 1968; Yotopoulos, 1968; Hayami and Ruttan, 1971, 1985; Evenson and Kislev, 1975; Nguyen, 1979; Yamada and Ruttan, 1980; Clayton, 1980; Antle, 1983; Brooks, 1983; Wong and Ruttan, 1983; Kawagoe, Hayami and Ruttan, 1985; Lin, 1989; Fleisher and Liu, 1992; and Johnson et al., 1994.

estimate is less than those parameters derived in earlier production studies of socialist agriculture ($\approx$0.23). This is largely because of economic transition.[577] However, it is difficult to assess the stage of economic development reached by the (former) socialised sector using the labour estimates as the accuracy of the employment data sets is in question.[578]

Other studies have produced an array of labour elasticities. For example, Cornia (1985) generated a labour elasticity of -0.39 (Korea) and 0.34 (Tanzania) in his study of fifteen LDCs. Of those countries which generated insignificant labour t-ratios (South East Asia and Uganda), labour-surplus conditions in agriculture were associated with low marginal productivities of labour (Cornia, 1985). Thus, negative aggregate private labour elasticities of the southern regions of Poland suggest private farming here is at an earlier stage in its agricultural development path.

In summary so far: analysis of the land (Part 7.2) and fertiliser (Part 7.4) variables suggests private farming in Poland is comparable with small-scale, subsistence farming found in LDCs (hypothesised in section 1.5). However, evidence relating to the capital[579] (Part 7.3) and labour (Part 7.5) variables remains inconclusive. Despite economic transition, analysis of all the (former) state sector variables implies a more advanced agricultural system. However, the results relating to the private north western region were somewhat unanticipated. It had been envisaged that a more advanced system of farming predominated here and admittedly, the low land elasticity estimate does confirm this supposition. However, as the results also suggested the role of operative capital and fertiliser was minimal, classifying north western agriculture in terms of socio-economic development, has been made more controversial.

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[577]The (former) state labour elasticity coefficient of 1988-1989 was 0.26 (see Table 6.5).

[578]Detailed in section 5.5.4.

[579]Despite private sector tractorisation nearing completion.

7.5.3 Polish agricultural production studies: the 'labour' elasticity coefficient

Table 7.13: Features of Polish Agricultural Production Functions[j]

Authors	Functional form(s)	Estimator(s)	Spatial range of analysis	Number of countries	Date of study	Labour elasticity coefficient[e]	
Boyd (1988, 1991)	CD[a]	IV[b]	Poland	1	1960-1982	0.16[p] (11.00)	0.82[s] (64.02)
Florkowski, Hill and Zareba (1988)	CD	3SLS[c]	Poland	1	1956-1983	-0.06[p] (-0.37)	0.25[s] (0.85)
Screene	CD	GLS[d]	Poland	1	1989-1993	0.106[p] (3.879)	0.081

[a]=Cobb Douglas; [b]=Instrumental Variable Function; [c]=Three Stage Least Squares; [d]=Generalised Least Squares (AR (1)); [e]=OLS estimate unless otherwise specified; [j]=Appendix VIII provides further details; [p]=private; [s]=state; t-ratio (from zero) at five per cent significance level in parentheses

[Source: Boyd (1988, 1991) and Florkowski, Hill and Zareba (1988)]

Earlier studies of Polish agricultural production were conducted during the same time periods, yet whilst Boyd (1988, 1991) produced positive labour elasticity parameters and high t-ratios, Florkowski, Hill and Zareba (1988) generated a negative private labour elasticity (-0.06) and low t-ratios. Although the national aggregate labour elasticity estimate generated by the private sector in this study is dissimilar from earlier studies, it is comparable with research on the Polish labour markets during 1988-1993 (Szemberg, 1992d).

Registered and hidden rural unemployment has grown rapidly since economic transformation[580] began to the extent that the number of unemployed in rural areas amounted to almost 1 million and the aggregate number of persons seeking full or part-time work was 1.4-1.6 million[581] by the end of 1993. The largest number of 'surplus labour' farms were primarily concentrated in the Northern regions (34 per cent) where (former) state farms[582] was the sole employer (confirming Hypothesis 1, section 1.5). Twenty six per cent were located in the southwest, a typically part-time farming region with poor infrastructure dependent on the nearby urban labour markets (Szemberg, 1992d). Furthermore, sixty one per cent of the 'surplus labour'

[580]This is largely due to urban-rural migration of semi-professionals who were unable to find work in the industrialised sector (Szemberg interview, 1994).

[581]Success of the policy for rural, agricultural and food economy sectors will be closely linked with other spheres of the country's political life including: financial policy, fiscal policy, social policy, food policy, property transformation policy, foreign trade policy, policy for science and dissemination of national scientific achievements, ecological policy, information policy and regional policy (MAF, 1994).

[582]Privatisation of the (former) state-owned farming sector has been fragmentary and piecemeal aggravating the rural labour market further (APA, 1994; Portugal, 1995; refer to Part 7.2).

are under the age of 25 and are well educated, but are either unable to find work or they remain at the farm to postpone economic independence (Szemberg, 1992d). Since there is no demand for them, the overall effect has been a depression in the marginal productivities of labour (Szemberg, 1992d; MAF, 1994; and Borek, Santorum, Szemberg, Wos, and Wagry farmers interviews, 1993/4).

Population growth until 2000 is likely to result in an expansion of the Polish workforce by almost 1 million persons. Consequently, the transfer of agricultural labour to the industrial and service sectors is likely to be severely inhibited, and reduction in the number of registered[583] or hidden[584] unemployed is unforeseeable in the immediate future. To alleviate the problem of rural unemployment and to ensure favourable structural agricultural transformation, one of the Polish government's policy objectives is to create 150 thousand new jobs on average each year. Foreign capital[585], tax allowances to stimulate growth in small and medium-sized enterprises (SMEs)[586] and desirable pension schemes[587] to entice older farmers[588] out of agriculture are the principle avenues adopted by the government to meet their objective (MAF, 1994).

Provisions have been made for two basic rural population groups: the agricultural population directly involved in agriculture and the rural population which is unconnected with agriculture. ARMA[589] focuses one of its activities on the

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[583]Over 300 thousand (MAF, 1994: 17).

[584]450-700 thousand (MAF, 1994: 17).

[585]This includes World Bank loans, PHARE and Know-How agricultural funds and, foreign direct investment (FDI). For example, the US accounts for 40 per cent of all FDI in Poland (Polish Hearth Club Conference, June 1995).

[586]According to Polish government policy, investors must initiate their businesses in communities of up to 10 thousand inhabitants. In addition, any entrepreneurial activity must compliment the local business community, provincial socio-economic development plans and nationwide agricultural policy (MAF, 1994). Some evidence of entrepreneurial activity has been manifested in the areas of Wagry and Rzgow as farms being converted into country holiday homes for tourism (Nowak interview 1994).

[587]Reform of social security benefits in 1990, and the extension of the entitlements and benefits of the retirement-pension scheme to private farmers, government spending on social measures for farmers increased dramatically to more than two-thirds of total budgetary expenditure on agro-food policies in 1991-1993 (Portugal, 1995).

[588]40 per cent of Polish farmers are in the 60-70 year age bracket; 32 per cent are over 70 years old (Szemberg, 1992d). Furthermore, the ratio of older farmers is higher in the southern and eastern regions of Poland (Dawson, 1982; detailed in 5.4.2).

[589]The Agency forms part of the government's 'Modernisation and Restructuring of Agriculture and Development of Rural Technical Infrastructure policy'. It was established in March 1994 and has taken over the financial means, rights and duties of the Agriculture Protection and Development Fund (see section 2.5).

'..restructuring of holdings to ensure better use of labour, technical means and land means, and thus to reduce production costs, adjust production structure to the market requirements and create alternative income sources for small and average holdings, improve the quality of products and meet the requirements of environmental protection and ecological standards of the domestic and foreign markets..'(MAF 1994: 12).

7.6 Summary

Parts 7.2 to 7.5 have analysed the aggregate elasticity coefficients of the conventional independent variables (land, capital, fertiliser and labour) generated by this Cobb Douglas model of Polish arable production (1989-1993). The magnitude of each production elasticity coefficient informs on the stage(s) of socio-economic agricultural development. Therefore, the results derived from this model of agricultural output have been used to test whether the private sector of Polish agriculture is comparable with LDC farming (Hypotheses 2-5, section 1.5). In summary, the variables measuring the land and fertiliser factor inputs have confirmed this supposition (Hypotheses 2 and 4, sections 7.2.2 and 7.4.2). Strictly speaking, however, the components estimating the contribution of operative capital and labour inputs to private agricultural production contest the theorem (Hypotheses 3 and 5, section 1.5). The regional results reflected the spatial diversification of Polish arable production. However, the model of private arable production in north western Poland generated some surprising results. Although this region was perceived to be the most advanced region of Polish private sector farming, the magnitude of the operative capital and fertiliser elasticity estimates were among the lowest of all regional regressions. Therefore, this may suggest capital plays a limited role in the processes of agricultural production (challenging Hypothesis 7, section 1.5).

The production elasticity parameters have also provided an insight into current problems of the Polish rural economy. An effective land management policy includes arable land set-aside for afforestation and infrastucture; privatisation of former state-owned farms and the establishment of reliable private property rights, via a complete and transparent legal system. The efficient allocation of capital (farming machinery) and inputs (fertilisers and feed) can be met with favourable conditions for domestic and foreign investment. These conditions include the creation of free functioning markets for money, operative financial institutions and low interest rates. As Polish agricultural restructuring continues, the successful relocation of the surplus rural labour force requires desirable pension schemes to entice older farmers out of agriculture, combined with absorption of labour by the industrial and service sectors (for example, in agro-tourism) and expansion in SMEs. Full implementation of the Polish government social and economic policy is essential for rural development and, is integral for continued growth in the national economy.

Chapter 8

Conclusion

This thesis has examined how Poland's primary sector has responded to economic change during the embryonic years of economic transformation. Poland is different from other Central and Eastern European countries currently in transition, as 76 per cent of its farm land remained in private ownership despite streneous efforts made by successive communist governments, especially in the 1950s, to control all factors of production. Today, small-scale, privately-run farms are the main food suppliers to the Polish national economy. The focus of this study, therefore, has been the Polish family farm.

Agricultural price liberalisation marked the first step towards marketisation on 1 August 1989, followed swiftly by a economic programme of rapid restructuring on 1 January 1990. The aftermath of policy reform was phenomenal, evident as an immediate decline of both agricultural and industrial production, and hyperinflation during 1989-1992 that gripped the Polish economy. Prices of farming capital (fertilisers; tractors and other machinery) outweighed market food prices, causing real agricultural wages to fall to such an extent that private farmers were subjected to a cost-price squeeze (sections 1.1 and 2.5). By 1992, the full effects of economic reform had filtered down to the producers and Polish arable production fell to its lowest level since 1989 (Chapter 5). However, the depression in (former) socialised arable output was far more pronounced than the fall in private production (section 6.5) as the factor-product relationship in (former) state farming altered significantly in the early transition period. This was owing to the institutional reform that had began on 1 January 1992, relating to Polish structural re-development. The establishment of private property rights and the divestitude of formerly state-owned farms has resulted in a substantial shedding of former public sector employment, privatisation of a small proportion of cultivated land, fertile soils set aside from production and the depletion of state-owned capital inventories.

Central to the research was an analysis of the national and regional input-output relationships of Polish arable production during the post-1989 period, the early years of economic transition. The empirical component of this thesis was completed using published and unpublished official agricultural statistics, consolidated with interview material gathered from 'key actors' located in Poland and Brussels (listed in Appendix I). Ad hoc localised information gathered in two villages, Wagry and Rzgow, provided further insights into the 'typical' structure of Polish farming.

An unrestricted log-linear Cobb Douglas production function has provided the theoretical framework of the thesis and, together with routine econometric estimation, a model of arable production has been developed to measure the determinants of Polish agricultural supply (Chapter 6). Secondary Polish arable and meterological data (1988-1993) used in the variable specifications yielded some reliable national regression estimates. The magnitude of the partial elasticities of production explained the Polish farming sectors' use of factor resources in arable harvest production. However, the smaller-sized sample distributions in the regional analyses have proved problematic (section 6.5). Adverse regression results, such as negative and statistically insignificant production elasticity coefficients are indicative of model misspecification. Specification errors (such as the omission of influential independent variables) were caused by inadequate secondary data sources and the restricted number of observations in the localised sample groupings. Secondly, negative aggregate labour elasticity coefficients (β) in the arable production functions generated by south eastern and western private farming, and north western (former) socialised agriculture violated the hypothesis of strict convexity, one of the assumptions underlying the Cobb Douglas production function (see Chapter 3 and Appendix VII). Their negative magnitudes implied the isoquants may have been actually concave or even upward sloping from the origin. In other words, relatively more expensive factor resources (capital) are used instead of relatively cheaper factor resources (labour) to reach the same harvest yields. Perhaps, unreliable labour data sets (data intrapolation and extrapolation were carried out before regression) together with small sample size distributions are accountable for the unanticipated results. More seriously, if the isoquants were really concave during 1989-1993, the results imply an economically inefficient combination of resources were used in the processes of production. It is likely that emerging free market forces and imperfect information would have generated unreliable price signals during the early years of economic transition. As competitive market forces become more transparent, a fully functioning price mechanism will lead to an efficient re-allocation of resources.

The theoretical and empirical contributions allowed analysis to be developed along two spatial scales: national and regional. Thus, it incorporated an understanding of the economic, political, institutional and behavioural factors associated with Poland's transition to a market-oriented economy. This was particularly apparent in the examination of the impacts of the emerging free market forces on the factor-product and resource-product relationships (Chapters 6 and 7); and the context within which these relationships function (Chapters 2 and 5). The research uncovered a bimodal farm size distribution which means a small number of very large farms and a large number of small, fragmented holdings sit side-by-side, producing the same products simultaneously. Consequently, the results obtained from the Cobb Douglas production analyses highlighted technical inefficiency in the private farming sector and, allocative inefficiency[590] in the (former) socialised sector (section 6.5). It is anticipated that free market forces, privatisation and plot consolidation, combined with some government intervention[591] will ensure that the structure of Polish agriculture evolves into a unimodal[592] size dispersion. In general this organisational arrangement has a more efficient allocation of resources; utilising more labour without hampering the level of output and without the loss of economies of scale (1.4.2.2 and 5.6.1).

As a dual system of agriculture has been operating in the Polish primary sector, the Polish government's agricultural policies until 2000 are focused on the structural transformation of the entire farming system. In short, three key issues have been identified to promote growth and development in the Polish rural communities. These include firm establishment of property rights via a complete and transparent legal system; structural reform; and access to credit. The institutional arrangements of farming affect ownership rights of factor resources, factor use, performance, and short and long-term incentives (section 1.4.2.1). Well defined private property rights are central to the successful privatisation of collective agricultural production as new owners will have complete autonomy over their land. Unlike state-managed farming, sole ownership is devoid of incentive problems typically found when property rights of land and labour do not belong to the same individual. However, it is extremely unlikely that capital and human investment will follow the same patterns of land ownership. Therefore, although a farmer may possess the property rights of a plot of land and employ a given number of farm workers to farm

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[590]The assumption of allocative inefficiency may be inappropriate as profit maximisation was not the sole pursuit of state sector farming (sections 2.4 and 6.5).

[591]Such as credit support for medium-sized private farms.

[592]Where the bulk of farms are of intermediate size and a relatively small number are at both the small and large extremes (section 5.6.1).

that land, it is improbable that he will also be able to provide the correct assortment of tools to produce maximum output. Mutual exchange of capital and other resources will lead to an improvement in the coordination of factors and higher productivity in the long-run. Ancilliary government organisations[593] have been established to facilitate the development of managerial know-how, innovative and collusive behaviour in private sector farming. Other costs borne by the individual owning and using all factors of production are losses in product specialisation. Nevertheless, privatisation of state property will eradicate other well-known organisational deficiencies such as soft budget constraints and civil service restrictions ensuring job security (section 1.4.2.1).

Nonetheless, agriculture seems to be the economic sector most resistant to privatisation across Poland and other 'Partners in Transition'[594] (Gorzelak, 1996). The Agricultural Property Agency of the State Treasury (APA) (under the Act 29th December 1993) was established in Poland to accelerate the sale or lease of (former) state sector property. One of its aims was to define ownership rights. However, the delay of 'several months to re-establish the ownership title and to organise the land register have made transactions in agricultural real estate almost impossible' (APA, 1994: 10). At the end of July 1994, 6 per cent of all former state owned assets had been sold outright or given away free of charge, 41 per cent actually leased to private farmers, and the remaining fixed assets had been managed by administrators or stewards (2.5.3 and 7.2.3).

Farm enlargement is necessary in order to reduce the number of farms which share the income of the agricultural sector. This will help the remaining farmers to fight the price-cost squeeze in agriculture by obtaining economies of scale and taking full advantage of modern technology (Ilbery, 1985; and Kasliwal, 1995). As long as the supply of labour grossly exceeds the demand for labour in Poland, agricultural incomes will remain low, widening the price-cost gap that already exists, deepening the burden of government support and intensifying rural poverty. A decrease in the number of farms is achieved by encouraging out-migration and in this respect, the Polish government has adopted two particular schemes to promote rural depopulation (2.5.4 and 7.5.3). First, structural unemployment that prevails in the northern and western areas is being absorbed by the industrial and service sectors together with the expansion of the small

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[593]Such as the UK Know-How Fund, the Agency of Restructuring and Modernisation of Agriculture (ARMA) and the PHARE programme (detailed in sections 2.5.4 and 7.2.3).

[594]The 'Partners in Transition' include Poland, Hungary, the Federal Czech and Slovak Republics and Slovenia.

and medium-sized enterprise sector. Second, the older-aged (> 60 years) surplus rural labour force in the southern and central regions is being enticed out of agriculture with pension schemes. However, earlier farm enlargement schemes that have been implemented in other countries (such as Sweden, Finland and India) have had limited achievement and the response from farmers has been poor. This reflects the voluntary nature of the schemes and the non-effectiveness of the financial incentives to leave agriculture. Farmers attracted to such schemes are those who would have retired from agriculture anyway. Another reason to expect little success is that many small-scale farmers are part-time and not dependent on farming for their total income. Therefore, this policy measure may prove less effective in the long-term than anticipated.

The Polish government is developing its free functioning markets for money too (Tangermann, 1993). Operative financial institutions and securing preferential interest rates on capital loans have been put in place to boost domestic investment and attract foreign investment. A number of Polish government agencies together with American, European and British funds have also been established to advance the restructuring process. Their chief task is the provision of financial assistance for plot consolidation, farm expansion and product specialisation, creating economies of scope and scale. However, access to credit for farm or regional level investment is ineffective unless behavioural change occurs at the same time. A farmer's attitude to risk and newer technology will directly affect the adoption and diffusion rates of technical innovation. Therefore human investment such as in education, the transfer of skills, managerial know-how and training are considerations also affecting farmers awareness and interest in new technology. The ability, desire and freedom to choose to invest in capital will improve land, capital and labour productivities, raising output. Other schemes involve the development of rural infrastructure; including roads and motorways, communications, electricity and gas supplies, irrigation and sanitation. Despite economic and social benefits derived from these projects, the International Monetary Fund has placed restrictions on Polish government spending from making greater rural investment to control the budget deficit. It will remain especially difficult for the government to fund any form of fiscal policy until an effective system of tax revenue collection is in place. Nevertheless, inadequacies in the rural infrastructure are cited as being one of the main obstacles to development and ones which are difficult for farmers to overcome by themselves (section 2.5.4).

Structural transformation in the rural communities is futile unless progress is made simultaneously in wholesale and food distribution. A very general institutional description of a food marketing chain might be that it involves five groups of economic agents: producers, country dealers, wholesalers/processors, retailers and consumers (Colman and Young, 1993). The institutions perform many functional aspects of the marketing chain including assembly, transport, storage, processing, financing, distribution and grading. All these functions share two principal characteristics. First, that they add value to the product and second, that they require a variety of inputs to perform and so incur costs. As long as the value-added (return for the product minus the cost of all inputs) in each function is positive, firms, entrepreneurs (and even farmers themselves) will find it profitable to compete to supply the service entailed. Vertical integration between companies to perform several aspects of the chain will lead to a reduction in market transaction costs (for example in storage or transportation costs). Growth in competition, a rise in the number of privately-run wholesalers and food-processing companies operating in the market will alter the present (former) state-run oligoplistic relationship between production and final consumption. More importantly, improvements in food quality, food processing, packaging and marketing will increase the market price of domestic produce. Sustained economic growth, and a rise in disposable income will boost Polish food demand, strengthening both domestic competitiveness and exporting capabilities. Finally, as the primary sector plays an integral role in the national economy, full implementation of the Polish government social and economic policies is crucial for economic growth. The pace and extent of structural reform in Polish agriculture until 2000 will affect Poland's time path of full European Union (EU) participation. An analysis of Polish agriculture's response to early economic transition would be incomplete without reference to its relationship with the EU. Therefore, it is to this subject that I now turn.

Organisational change in international trading agreements and currency devaluation are aspects of the economic and political restructuring programmes which have been sweeping Poland and other Central and Eastern European Counties (CEECs). After the collapse of Comecon in 1989, former socialist states have had to re-develop their trading relationships. As the re-establishment of pre-communist trading routes remains troublesome and, despite alliances with new trading partners, most of Poland's foreign trade has been directed towards the EU to such an extent that an asymetrical trade flow now exists (2.5.2). There are a number of reasons which have explained this Poland-EU trade imbalance. First, it is a result of the EU protectionist policies within the EU-Poland Association Agreements (in force since 1 March 1992). Second, the substantial capacity of the post-socialist agricultural sectors and their relatively lower standards of living (section 7.1). Third, current agricultural protection is less intensive in the CEECs than in the EU (Tangermann, Josling and Munch, 1994; and Hartmann, 1996). Fourth, Polish farmers are not yet maximising their EU quotas. In this respect, Kwiecinski (1994) reported that in 1992 Poland filled its preferential quotas for only 30 per cent of the products subject to quotas (section 2.5.1). All of these factors are preventing Poland and other CEECs from immediate full EU participation.

Full EU membership is viewed as the definitive stage in Polish economic and political transition (Wierczorek interview, 1994). Yet, a pre-condition of full EU membership is an alignment with the Common Agricultural Policy (CAP). CAP expansion to Poland and other CEECs in its present form would cause EU agricultural support expenditure to escalate, violating the World Trade Organisation (WTO) farming mandate, and placing enormous financial pressure on other economies already within the EU. For example, Portugal's present position as a net receiver of EU funds is likely to alter significantly after EU accession of just the 'Partners in Transition'. As the CAP already absorbs 50 per cent of the total EU budget, there is ample justification for continued CAP reform. Secondly, the implementation of the CAP through quotas, subsidies and set-aside payments would frustrate the developing agricultural markets within the CEECs, affecting producers, consumers and governments. As full EU membership is a long-term issue, in the meantime the CEECs need to redirect the emphasis towards grassroot development in their primary sectors. This is especially important as internal wranglings are likely to delay an eastward enlargement of the EU. Recent health scares (such as Bovine Sporangiform Encephalopathy (BSE)) have increased public awareness of health and food issues, but have also placed additional financial pressure on EU member states. Political and economic controversy over the Single European currency, the social charter, minimum wage and EU accession of Cyprus and Malta are also likely to postpone an eastward EU expansion.

Since 1989, the main thrust of Poland's government policies have been the transfer from a centrally planned to a market mechanism. The overall desired economic effects include alteration in the structure of production and a behavioural change such that the allocation of resources is based upon the relative scarcity of goods. Secondly, greater competition should strengthen incentives to improve performance in making the best use of resources. Both of these aims will not be reached unless domestic and international market integration go hand in hand

(Tangermann, 1994). After six years of rapid economic restructuring, Poland's annual economic growth rate has risen consecutively and forecasts until the end of this millennium are good. However, the re-election of a coalition government comprising of the Left Democratic Alliance (former communists) and the Peoples Peasant Party in October 1993 and 1995 has illustrated public disappointment and disillusionment in the new economic system (2.4). The escalation in social costs and the erosion of the welfare system have resulted in widening income disparity, a substantial increase in unemployment, rising crime, homelessness, poverty and nationalism. As people in former socialist countries grapple with the forces of the 'invisible hand', the collapse of communism in the latter part of the 20th century has revived debate in economic, political and social systems in the optimum allocation of economic resources. The role of institutions and regional policies has been reawakened (see 1.1). While academics inside and outside Poland are preoccupied with advancing theoretical arguments, the future for Polish agriculture is extremely bleak. In short, the social costs of adapting to a competitive free market economy is the loss of livelihood for 1.5 million farmers.

8.1 Hypotheses

There have been two main aims of this thesis. The first was to examine the response of Polish agriculture to current economic change. The second was to consider the primary sector's role in the course of socio-economic development, centring the analysis specifically upon variations in Polish arable production during this period. From a synthesis of these aims, and the theoretical context of the study, seven hypotheses were identified in Chapter One, and in subsequent chapters, the empirical work has been undertaken.

Hypothesis One:	The establishment of private property rights will lead to substantial shedding of the (former) socialised agricultural workforce

The institutional reorganisation of central production has had a substantial impact on (former) state sector farming. Privatisation of state-owned property and the introduction of private property rights has resulted in a re-orientation of factor resources to private sector farming. Almost 4 million hectares of state agricultural land have passed under the jurisdiction of the APA since 1990. By the end of July 1994, 6 per cent had been sold outright or transferred free of charge, 41 per cent had been leased mainly to private farmers located in north western Poland (APA, 1994). The remaining fixed assets are being developed by Agency companies into large, mainly hired labour estates. However, the divestitude of state farms has proved difficult as the farms are hampered by huge debts and former state-owned resources have even been left abandoned (detailed in sections 2.5.3, 5.5.1.1 and 7.2.3).

Restructuring of state farms has had a tremendous impact on rural labour markets too as new ownership has radically altered the preceding employment and staffing arrangements. According to the APA, 19.4 per cent of the total workforce employed in socialised farms were either dismissed or offered early retirement, verifying Hypothesis One.[595] This is putting additional pressure on the already overburdened rural labour markets to such an extent that structural rural unemployment has been cited as one of the major barriers facing successive economic and social development in the Polish farming community. Registered and hidden rural unemployment has grown rapidly since economic transformation began to the extent that the number of unemployed in rural areas amounted to almost 1 million and the aggregate number of persons seeking full or part-time work was 1.4-1.6 million by the end of 1993. The largest number of 'surplus labour' farms were primarily concentrated in the Northern regions (34 per cent) where (former) state farms was the sole employer (Szemberg interview, 1994; see 2.5.3, 5.4.2 and 7.5.3). Furthermore, sixty one per cent of the 'surplus labour' are under the age of 25 and are well educated, but are either unable to find work or they remain at the farm to postpone economic independence (Szemberg, 1992d). Since there is no demand for them, the overall effect has been a depression in the marginal productivities of labour.[596]

Therefore, in view of the qualitative source material gathered in Poland during 1993/4, the first Hypothesis must be accepted.

Hypotheses 2-5 relate specifically to the empirical results derived from the unrestricted Cobb Douglas agricultural production function. They are centred on the small-scale private farmer, the main agricultural producers in Poland. The magnitudes of the aggregate national production elasticity parameters generated by each model of Polish output reflected the relative importance of the independent variables in arable harvest yields during 1989-1993.

[595]APA, 1994; see Table VI.2, Appendix VI.

[596]Szemberg, 1992d; MAF, 1994; and Borek, Rowinski, Santorum, Szemberg, Wos, and Wagry farmers interviews, 1993/4.

Contextualisation of the empirical results in this thesis within earlier non-Polish and Polish-based agricultural production functions provided insights of the structure and stage(s) of agricultural development of each sector of Polish farming. It is important to bear in mind the problems of estimation usually associated with studies of agricultural productivity. They are all too often hampered by caveats relating to the nature of the data and the haphazard way in which empirical work is performed. The time periods taken, the data used, and the methodology employed, all vary within and between countries (Chapters 3 and 4). The empirical component of this thesis was restricted also by inaccurate data sets arising from a country undergoing economic transformation (Chapter 5).

Hypothesis Two:	The magnitude of the private national aggregate land elasticity parameter lies between -0.07-0.86.

The Polish private aggregate land elasticity estimate (0.91) during 1989-1993 exceeds the scope of parameters described by previous studies of developing agriculture (-0.07 and 0.86) (Tables 1.1 and 7.3). Strictly speaking, Hypothesis Two is therefore rejected. As the magnitude of the land estimate is particularly large, the implication is that private farming uses land intensively in the processes of arable production. These results complement work by Lau and Yotoupoulos' (1968), Antle (1983) and Cornia (1985). The only study to have generated a land elasticity estimate similar in magnitude to the one produced by the Polish private sector is the Less Developed Countries (LDCs) subsample in Lau and Yotoupoulos' (1968) study (0.86). As this land elasticity estimate was generated by an LDC subsample, one can speculate that their cross-sectional agricultural production function is consistent with private agriculture in Poland during 1989-1993. Antle (1983) also used subsampling to distinguish between industrialised countries and LDCs in his meta-production function of agriculture across 66 countries in 1965. His subsample of LDCs generated a higher land elasticity estimate (0.44) than his grouping of industrialised countries (0.16). Cornia (1985) conducted a cross-sectional agricultural production study of 15 LDCs in 1970. He found agriculture to be generally more land-intensive when it is at an earlier stage of development. As agriculture develops, tools and capital inventories become more accessible to farmers and the land estimate declines as the capital or labour parameters expand (Cornia, 1985; detailed in sections 1.4.2.2, 7.2.2 and 7.5.2, and Chapters 3 and 4).

The empirically-derived private land elasticity parameter of this study has been contextualised within earlier production studies of LDCs. Strictly speaking, Hypothesis Two cannot be accepted, yet the large private land elasticity estimate still demonstrates 'land' was the most significant contributor to private arable production during 1989-1993. It has also shown privately-owned farms in Poland are land-intensive, suggesting an agricultural system comparable with farming in LDCs.

Hypothesis Three:	The magnitude of the private national aggregate operative capital elasticity coefficient deviates from 0.06-0.14.

The private national aggregate operative capital elasticity coefficient was 0.17 during 1989-1993, falling outside the LDC range of estimates (0.06-0.14) (Tables 1.1 and 7.6). Therefore, analysis of the variable measuring 'operative capital' in this study suggests the private sector of Polish farming is as least as capital-intensive as agriculture in the LDCs. In fact, its magnitude is closest to that generated by the subsample of industrialised countries (0.18) in the study by Kawagoe, Hayami and Ruttan (1985) (Table 7.6). This stipulates rejection of Hypothesis Three.

Generally speaking, the magnitude of the capital elasticity estimates generated by LDCs is lower than those produced by industrialised countries, simply because agriculture in developing countries is less capital and more land-intensive (sections 1.4.2.2 and 7.3.2). For example, in Cornia's cross-sectional study of fifteen LDCs, the capital elasticity coefficients oscillated around 0.10-0.20 often with insignificant t-ratios (Cornia, 1985). Other research by Lau and Yotopoulos (1968), Yotopoulos (1968), Lin (1989) and Fleisher and Liu (1992) all generated a low capital elasticity coefficient in their agricultural production studies implying an earlier stage of agricultural development[597] (section 7.3.2).

It is important to remember that this productivity analysis is a quantitative-based study, formed upon the assumptions of homogenous capital inputs and disembodied technical progress (Chapter 3). The estimates provide no information relating to quality or types of tractors, rates

[597]The capital elasticity coefficients were 0.06 in the studies by Lau and Yotopoulos, 1968, Yotopoulos, 1968, Lin, 1989 and Fleisher and Liu, 1992. The magnitude of the capital elasticity estimate was 0.14 in the LDC subsample in the study by Kawagoe, Hayami and Ruttan, 1985 (displayed in Tables 1.1 and 7.6; detailed in sections 1.4.2.2 and 7.3.2).

of capital utilisation, rented capital, or the average tractive horsepower (Chapter 5). Moreover, use of the disembodied technical progress hypothesis may have even underestimated the role of operative capital in private arable production (Chapter 3). Therefore, based purely upon the empirical results of this study, as 'operative capital' plays a more significant role in Polish private arable production than it does in developing farming, Hypothesis Three must be rejected and inferences remain controversial.

Hypothesis Four:	The magnitude of the private national aggregate fertiliser elasticity estimate lies within the range 0.02-0.14.

The private national aggregate fertiliser elasticity parameter (1989-1993) was 0.11, lying within the specified realm of estimates determined by earlier agricultural production studies of LDCs (0.02-0.14).[598] This provides confirmation of Hypothesis Four.

Studies by Lau and Yotopoulos (1968), Kawagoe, Hayami and Ruttan (1985), and Fleisher and Liu (1992) have shown the magnitude of the fertiliser elasticity parameter and its t-ratio is generally larger in the set of industrialised countries than the LDC subsample. There are three arguments to explain this condition. First, farming systems in the LDCs rely more heavily upon the relatively inexpensive factor resources (land and labour) than the relatively more expensive factors (such as capital or fertiliser) in the production process. Second, the magnitude of the fertiliser elasticity parameter is affected by the size distribution of farms and the organisational structure of the prevailing farming system. Small-scale farms are far less likely to be exposed to the technologically more advanced agricultural practices used in large-scale, commercial farming. Therefore, technical diffusion and the transfer of knowledge from the large to the small farms simply does not occur. Third, research and the role of technical institutions also affect the pace at which newer farming techniques are developed and adopted. Earlier agricultural production studies of the industrialised and (former) socialist countries have generated high elasticity coefficients for fertiliser, education and research simultaneously. Therefore, the allocation of public resources (government expenditure) and the role of private institutions have an additional impact on the magnitude of the fertiliser elasticity parameter (sections 1.4.2.2, 5.6.1 and 7.4.2).

[598]Presented in Tables 1.1 and 7.9.

Hypothesis Five:	The magnitude of the private national aggregate labour elasticity value ranges between 0.19-0.56.

As the Polish private national aggregate labour elasticity (0.11) deviates from the range of parameters derived by earlier LDC studies (0.19-0.56), the fifth Hypothesis cannot be accepted. Therefore, the role of 'labour' in private arable production remains inconclusive. In fact, the Polish private labour coefficient is closest to the labour elasticity parameter of 0.12 which was generated by Brooks (1983) in his time series farming analysis across the Soviet Union, US, Canada and Finland (Table 7.12; section 7.5.2). This rather unanticipated result is likely to have been caused by the random processes used in the estimation of labour as a factor input.

Other studies have also produced an array of labour elasticities. For example, Cornia (1985) generated a labour elasticity of -0.39 (Korea) and 0.34 (Tanzania) in his study of fifteen LDCs. Of those countries which generated insignificant labour t-ratios (South East Asia and Uganda), labour-surplus conditions in agriculture were associated with low marginal productivities of labour (Cornia, 1985). An assessment of the impact that manpower has on agricultural production is probably the most difficult of all variables to accurately measure (Chapters 4 and 5). This is especially so for Poland as extrapolation of each labour data set took place prior to regression (Chapter 6).

To summise, the national contribution of 'labour' to the processes of private arable production has in fact proved lower than expected. These results suggest farming is generally less labour-intensive than agriculture in LDCs. However, due to three inter-related factors, the accuracy of the Polish rural employment data set is very much in question. First, incomplete trends in labour inputs meant data extrapolation took place before regression (Chapters 5 and 6). Second, data limitation resulted in the exclusion of part-time and seasonal agricultural workers (section 5.5.4). Third, an accurate assessment of the urban-rural migration that took place during 1989-1993 is likely to have resulted in a larger labour elasticity coefficient (section 7.5.3).

In conclusion, analysis of the national aggregate 'land' and 'fertiliser' elasticity coefficients (Chapters 6 and 7) have illustrated the private sector of Polish agriculture is at an early stage of its development path, comparable with subsistence farming (Hypotheses 2 and 4). On the other hand, the variables measuring 'operative capital' and 'labour' have implied a more advanced system of farming predominates (Hypotheses 3 and 5). However, it is important to remember that the accuracy of the labour data sets remains in question. Nevertheless, small-scale, multi product private farms have been functioning alongside the state farms producing the same produce concurrently, unlike other post communist countries (2.3 and 5.6.1). These farms have been providing mainly organic arable produce using predominantly land-intensive farming procedures. Therefore, quantitative investigation within this research confirms acceptance of Hypotheses 2 and 4, but rejects Hypotheses 3 and 5.

The last two Hypotheses relate to the spatial diversification of Polish arable productivity. The historical movements of capital and non-capital factor resources have shaped development of the Polish landscape (sections 1.5, 2.4 and 5.4.2). The area-specific production functions derived in the empirical analyses of this research have been used to test whether private north western Poland is the leading agricultural quarter. This is because larger private farm units here have led to higher land, labour and capital productivities and economies of scope and scale (5.4.2). Closer proximity to Western European markets is likely to increase future competitiveness and mutual exchange in agricultural trade.

A comparative analysis of the private north western production elasticity coefficients with other regional elasticities was carried out using agriculture production theory (Chapter 7).

Hypothesis Six:	The magnitude of the northwest aggregate land elasticity estimate will be lower than its southern and eastern counterparts.

In support of Hypothesis Six, the north western private aggregate land elasticity (0.443) estimate is lower than those generated by its south western (1.263), south eastern (0.787) or north eastern (0.759) neighbours (Tables 7.1 and 7.2). The results imply private agricultural production in north west Poland is less land-intensive and is at a more advanced stage in agricultural development than the remaining quarters. Therefore, the sixth Hypothesis is accepted.

Hypothesis Seven:	The magnitude of the northwest aggregate operative capital and fertiliser elasticity estimates will have a greater magnitude than those generated by the southern and eastern areas.

Contrary to a priori expectations, the magnitude of the private north western operative capital estimate (0.141) and fertiliser elasticity coefficient is (0.166) are lower than the parameters generated by the other quarters.[599] Based upon both sets of empirical results, Hypothesis Seven cannot be accepted. However, there are a number of theoretical and statistical considerations which may have influenced the private north western production function. First, use of the disembodied technical progress hypothesis is likely to have undervalued the size of the operative capital elasticity estimate (sections 3.5 and 6.5). Second, there is evidence of a re-direction of north western private sector investment expenditure into other factor resources, such as land, machinery (other than the tractors), farm buildings or livestock (Szemberg, 1992c). During 1988-1992, the northwest focused on increasing its present level of inventories to meet Western European standards (sections 5.4.2 and 7.3.3). Third, the small sample regional data distributions with a limited number of observations may have caused incorrect statistical estimation, or more simply, inadequate data sources may have generated erroneous regressions (Chapter 4; sections 5.4.2 and 6.5).

The results relating to the private north western region were somewhat unanticipated. Admittedly, the low land elasticity estimate does confirm private agriculture in this region is less land-intensive than private farming in the other quarters. However, the magnitude of both the operative capital and fertiliser elasticity estimates were among the lowest of all private sector regions, perhaps suggesting a less capital-intensive production process. As other empirical research unearthed a tendancy for north western farmers to direct capital expenditure into other factor resources, credibility of using 'tractors' as a measure of 'capital' is called into question. Nevertheless, while Hypothesis Six is accepted, strictly speaking, Hypothesis Seven must be rejected.

8.2 Future implications

This research has a number of implications for both academic and policy work. First, it has identified that regional differences in agricultural performance in Poland are significant and thus regional disparities should be corrected to improve overall national performance. Property rights, structural transformation, farm enlargement and acceleration in the privatisation of state-owned land are the institutional factors which will in part stimulate growth and development. However,

[599]The operative capital elasticities of the northeast, southeast and southwest were 0.339 (t-ratio=1.494), 0.528 (t-ratio=4.816) and 0.242 (t-ratio=0.701) (Tables 7.1 and 7.5). The fertiliser elasticity estimate of the southeast and southwest were 0.205 and 0.181 (t-ratio=5.940) (Tables 7.1 and 7.8).

there are two other inter-related contributory variables which could modify the spatial imbalances in Polish agricultural productivity: research, technology and development (RTD); and regional policy. Researchers throughout the world have consistently found the role of RTD stimulates technological progress in every sphere of agriculture, leading to an outward shift in the isoquants, alteration in the long-run agricultural production function and higher farming incomes. Although research in Poland today is generally of high quality, there are constraints on the effective use of research resources. For example, agricultural research has been largely production oriented, and geared to large state farms and cooperatives, which received preferential treatment for inputs. Hence, widening gaps have opened up in recent years between actual and potential yield, as inputs have been in short supply and these large agricultural entities have ceased to receive preferred status. At present, there is virtually no research by the private sector, although it is seems desirable to encourage it as it would reduce the burden on the public budget, and stimulate innovation through competition (World Bank, 1990). Agricultural Extension Service Centres have had an important impact on the rural environment, but shortcomings still exist. Primarily, these failings have been related to a growing emphasis on raising output levels rather than profit maximisation, and the neglect of Poland's main food producers: small-scale farmers (section 4.2.6).

As part of the present government's socio-economic policies to 2000, a non-institutional inter-departmental research team has been established to prioritise issues concerning rural areas, agriculture and the food economy. The co-ordinating team includes representatives of academic institutions (such as Polish Academy of Science) combined with the Ministry of Agriculture and Food, Ministry of Education and Ministry of Environmental Protection. Coordination of the work will be sustained by the establishment of a national information system on agricultural research, located in the Central Agricultural Library. To consolidate the link between scientific, agricultural research and education, the present government is committed to establishing regional centres for practical professional training. Agricultural schools will also take active part in alternative training of the rural unemployed (MAF, 1994). As the IMF has placed restrictions on Polish government spending, financial support for agricultural RTD is currently limited. However, foreign-based RTD projects (e.g. PHARE and UK Know-How Fund programmes) could also help to alter the qualifications structure of the Polish rural workforce. Other research, such as a survival analysis of small-scale private farmers would also provide further insights into specific regional problems surrounding the socio-economic context of economic transition.

The socio-economic effects of the processes of economic transformation since 1989 have been regionally differentiated. For example, high agrarian overpopulation and low incomes are characteristic of some localities in south eastern and Central Poland (e.g. the Kielce voivodship (county)). An ageing agricultural workforce is a prominent feature of the northeast. Similarly, the threat of severe structural unemployment in north western Poland, where state farms once dominated, is likely to affect its potential growth rate (e.g. Elblag and Slupsk voivodships (counties)). Discrepancies will continue to deepen unless an integrated approach to the spatial aspects of the Polish rural economy is pursued. Growth in tourism, forest and environmental management, infrastructure and expansion of SMEs is crucial to economic transformation of the primary sector in the long-term.

BIBLIOGRAPHY

ABRAMOVITZ. M. 1956: Resource and Output Trends in the United States since 1870. **American Economic Review**, papers and proceedings. May.

AGRA EUROPE Ltd., 1990. **Agra Europe Special Report No.56. Prospects for Agricultural Trade in Central and Eastern Europe. A view from Poland**. Kent: Agra Europe (London) Ltd.

AGRA EUROPE Ltd., 1995. **East Europe Agriculture and Food**, 153, (June).

AIGNER, D., (et al) 1977. Formulation and Estimation of stochastic frontier production function models. **Journal of Econometrics,** 6: 21-37.

ALI, F. & PARIKH, A., 1992. Innovations on Family Farms: The Nazareth Region in Israel. **American Journal of Agricultural Economics,** 74 (2).

ALEXANDER, T., 1989. **An Analysis of some of the determinants of agricultural productivity in sub Saharan Africa.** PhD Thesis. US: University of Maryland.

ANDERSON, K., 1990. **Comparative Advantages in China. Effects on Food, Feed and Fibre Markets**. Paris: OECD.

ANDERSON, R., & TANGERMANN, S., 1991. Agricultural Price and Trade Policy in Poland. (Working Paper 1). Agricultural Price and Trade Policy and Agricultural Budget. Agricultural Sector Adjustment Loan Supporting Volumes, 1. Warsaw: Ministry of Agriculture and Food Economy (MAF).

ANTLE, J., 1983. Infrastructure and aggregate agricultural productivity: International evidence. **Economic Development and Cultural Change,** 31 (3), pp. 609-18.

ANUSZEWSKI, 1993. Interview with Director Anuszewski, Forecasting and Planning

Department, Warsaw, MAF.

APA, 1994. Report on the activities of the Agricultural Property Agency of the State Treasury in 1993. Warsaw: Agricultural Property Agency of the State Treasury.

ASH, T., 1992. Agricultural Reform in Central and Eastern Europe: Marketisation, Privatisation, Developing a New Role for the State. **Communist Economies and Economic Transformation,** 4 (4).

ASH, T., & HARE, P., 1994. Privatisation in the Russian Federation: changing enterprise behaviour in the transition period. **Cambridge Journal of Economics,** 18, pp. 619-34.

ASHTON, J., & ROGERS, S., ed., 1967. **Economic Change And Agriculture**. London: Oliver and Boyd.

BAIRAM, E., 1991. Elasticity of Substitution, Technical Progress and Returns To Scale in Branches of Soviet Industry: A new CES Production Function Approach. **Journal of Applied Econometrics,** 6, pp. 91-96.

BACHMAN, K., & CHRISTENSEN, R., 1978. The Economics of Farm Size. **In: H. SOUTHWORTH & B. JOHNSTON eds., 1967. Agricultural Development and Economic Growth**. N.Y.: Cornell University Press, pp. 234-57.

BAKER, D., 1994. Interview with Dr Derek Baker, Agricultural Sector Adjustment Programme Office, Foundation of Assistance Programmes for Agriculture (FAPA), 12 October 1994. Warsaw, MAF.

BALCEROWICZ, L., 1993. Transition to Market Economy: Central and East European Countries in Comparative Perspective. Paper presented at the Conference on 'Transformation in Central and Eastern Europe: Economic Theory in Practice', 26 February 1993. Staffordshire University Business School: CEREB.

BALCEROWICZ, L., 1994. Eastern Europe: Economic, Social and Political Dynamics, the Sixth M. B. Grabowski Memorial Lecture. London: School of Slavonic and East European Studies.

BALDWIN, R., 1992. An Eastern Enlargement of EFTA: Why the East Europeans should join and the Eftans should want them. Centre of Economic Policy Research. Occasional Paper, 10.

BALDWIN, R., 1994. Towards an Integrated Europe. Centre of Economic Policy Research.

BALL, E., 1992. Sources of Agricultural Economic Growth and Productivity: Discussion. **American Journal of Agricultural Economics,** 74 (3).

BALTAGI, B., & RAJ, B., 1992. A survey of recent theoretical developments in the economics of panel data. **Empirical Economics,** 17, pp. 85-109.

BALTAGI, B., 1995. **Econometric Analysis of Panel Data.** Chicester: John Wiley & Sons Ltd.

BANKS. 1994. Interview with Mr Simon Banks, External Secondment to DG I, ex-British Embassy in Warsaw, Brussels.

BANNOCK, G., BAXTER, R., & DAVIS, E., 1987. **Dictionary of Economics**. 4th ed. Suffolk: Richard Clay Ltd.

BARBER, L., 1995. Brussels rules out big budget rise to fund EU expansion. Financial Times, October 1995.

BARCHFIELD, J., 1979. **Land Productivity and Social Productivity In Mexico**. Wisconsin: University of Wisconsin-Madison.

BARTHOLDY, K., 1995. Statistical Review. **The Economics of Transition,** 3 (2).

BARZEL. Y., 1989: **Economic Analysis of property rights**. Cambridge: Cambridge University

Press.

BATTESE, G., MALIK, S., & GILL, M., 1996. An Investigation of Technical Inefficiencies of Production of wheat farmers in four districts of Pakistan. **Journal of Agricultural Economics**, 47 (1).

BBC, 1994. **A Difficult Homecoming**. Money Programme Production.

BBC, 1993. **The Heavyweight Contender: Europe on the Brink, Part 2**. Assignment Production.

BEATTIE, B., & TAYLOR, C., 1985. **The Economics of Production**. N.Y.: John Wiley & Sons.

BECKER. L.C., 1977. **Property Rights: philosophical foundations**. London: Routledge & Kegan Paul.

BEDLECHOWICZ. 1993. Interview with Professor Bedlechowicz. Department of Agriculture and Food Management, Regional Office, Lodz voivodship (county).

BEREND, I., & RANKI, G., 1974. **Economic Development in East Central Europe in the 19th and 20th centuries**. London: Columbia University Press.

BERRY, R., & CLINE, W., 1979. **Agrarian Structure and Productivity in Developing Countries**. US: John Hopkins University Press.

BHATTACHARJEE, J., 1955. Resource use and productivity in world agriculture. **Journal of Farm Economics**. 37 (1), pp. 57-71.

BHATTACHARVYA, A., & BHATTACHARVYA, A., 1996. Government Interventions, Market Imperfections, & Technical Inefficiency in a Mixed Economy: A Case study of Indian

Agriculture. **Journal of Comparative Economics,** 22 (3).

BIALOBRZYCK. 1994. Interview with Mr Bialobrzyck, Commission, DG I, PHARE, Agriculture. Brussels.

BIRCHENHALL, C., & GROUT, P., 1984. **Mathematics for Modern Economics**. Oxford: Philip Alan Publishers.

BINSWANGER, H., & RUTTAN, V., 1978. **Induced Innovation, Technology Institutions and Development**. Baltimore, MD: John Hopkins University Press.

BLAZYCA, G., 1996. **Observations on the Polish Transformation-Are there really no 'third ways'?** University of Paisley: Economics and Management. (Working Papers).

BOREK, T., 1993 & 1994: Interview with Tadeusz Borek, Programme Coordinator, Agricultural Sector Adjustment Programme Office, FAPA, 6 July 1993. Warsaw, MAF.

BOWLER, I., 1983. Structural Change in Agriculture. In **M. PACIONE ed., 1983. Progress in Rural Geography**. London: Croom Helm.

BOYD, M., 1988. The Performance of Private and Socialist Agriculture in Poland: The Effects of Policy and Organisation. **Journal of Comparative Economics**, 12, pp. 61-73.

BOYD, M., 1991. **Organisation, performance and system choice: East European agricultural development**. Colorado: Westview Press.

BRAVERMAN, A. (ed.), BROOKS, K. & CSAKI, C. 1993. The Agricultural Transition in Central and Eastern Europe and the formr U.S.S.R. Washington D.C: World Bank.

BREMON, P., 1994. Interview with Mr Pascual Bremon responsible for EC Trading Relations with Poland and other Eastern European countries. Brussels, Commission DG I.

BROCK, G., 1994. Agricultural Productivity in Volgograd Province. **Comparative Economic Studies**, 36 (1) (Spring).

BROOKS, K., 1983. The Technical Efficiency of Soviet Agriculture. **In: D. JOHNSON & K. BROOKS eds., 1983. Prospects for Soviet Agriculture in the 1980s**. Bloomington: Indiana University Press.

BROOKS, K., 1991. Price Adjustment and Land Valuation in the Soviet Agricultural Reform: A View Using Lithuanian Farm Data. **European Review of Agricultural Economics**, 18, pp. 19-36.

BULLOCK, D., 1992. Redistributing Income Back to European Community Consumers and Taxpayers through the Common Agricultural Policy. **American Journal of Agricultural Economics**, 74 (1).

BURRELL, A., HILL, B., & MEDLAND, J., 1990. **Agrifacts**. A Handbook of UK and EEC Agricultural Food Statistics. Hertfordshire: Harvester Wheatsheaf.

BUTT, S., 1994. Interview with Mr Simon Butt, the UK Representative for EC relations with Central and Eastern Europe. Brussels.

BYLINSKI, J., 1990. Interview with Janusz Bylinski, Member of Parliament, Minister of Agriculture, and Chair of the Parliamentary Committee for Agriculture. **In: SHEN, R., 1992. The Polish Economy. Legacies from the Past, Prospects for the Future**.

CAPSTICK, M., 1970. **The Economics of Agriculture**. London: Allen & Unwin Ltd.

CASSON, M., 1994. Enterprise Culture and Institutional Change in Eastern Europe. In: BUCKLEY, P., & GHAURI, P., eds., 1994. The Economics of Change in East and Central Europe: Its impact on International Business. UK: Harcourt Brace & Co, Academic Press.

CENTRAL EUROPEAN MARKETS, 1995, 15 (8) (April), p. 4.

CHAMBERS, R., 1988. **Applied Production Analysis: a dual approach**. N.Y.: Cambridge University Press.

CHANG, H., & NOLAN, P., eds., 1995. **The Transformation of the Communist Economies against the Mainstream**. Basingstoke and London: MacMillan.

CHIANG, A., 1984. **Fundamental Methods of Mathematical Economics**. 3rd ed. Singapore: McGraw-Hill.

CHOWDHURY, S., NAGADEVARA, V., & HEADY. E., 1975. A Bayesian Application on Cobb Douglas Production Function. **American Journal of Agricultural Economics**, (May), pp. 361-63.

CHOYNOWOKI, 1993. Interview with Director Choynowoki, Property Agency of State Treasury. Lodz Voivodship (county).

CLAYTON, E., 1980. Productivity in Soviet Agriculture. **Slavic Review**, 39, pp. 446-58.

COLMAN, D., & YOUNG, T., 1993. **The Principles of Agricultural Economics. Markets and Prices in Less Developed Countries**. Cambridge: Cambridge University Press.

COMMISSION OF THE EUROPEAN COMMUNITIES, 1992. **Agriculture in Europe. Development, Constraints And Perspectives**. Luxembourg: Statistical Office of the European Communities.

COOK, P., & NIKSON, F., 1995. **The Move to the Market? Trade and Industry Policy Reform in Transitional Economics**. London: MacMillan.

CORNIA, G., 1984. The Long Term Agricultural Production Function: An Analysis on Farm level data for fifteen Developing Countries. **Statistica**, 44 (3), pp. 525-38.

CORNIA, G., 1985. Farm Size, Land Yields and the Agricultural Production Function: An Analysis for fifteen Developing Countries. World Development, 13 (4), pp. 513-34.

DALLAGO, B., BREZINSKI, H., & ANDREFF, W., 1992. **Convergence and System Change. The Convergence Hypothesis in the Light of Transition in Eastern Europe**. England: Dartmouth Publishing Company Limited.

DAVIES, N., 1981. **God's Playground: A History of Poland**. Oxford: Oxford University Press.

DAWSON, A., 1982. **Studies in Eastern Geography: Eastern Europe**. Great Britain: Unwin Brothers Ltd.

DENISON. E. 1962. **The Sources of Economic Growth in the US and the Alternatives before Us**. NY: Committee of Economic Development, Library of Congress.

DICKE, H., 1995. The Envisaged Accession of Poland to the EC and its Implications for the Common Agricultural Policy of the EC. The Kiel Institute of World Economics: Kiel Working Paper no. 64.

DIELMAN, T., 1989. **Pooled Cross sectional and Time Series data Analysis**. N.Y.: Marcel Dekker.

DOGRAMACI, A., & FARE, R., eds., 1988. **Applications of Modern Production Theory: Efficiency and Productivity**. Lancaster: Kluwer Academic Publishers Group.

DOLL, J., 1974. On Exact multicollinearity and the Estimation of the Cobb Douglas Production Function. **American Journal of Agricultural Economics**, 56, pp. 556-63.

DOUGHTERY, C., 1992. **Introduction to Econometrics**. N.Y.: Oxford University Press.

DUBRAVCIC, D., 1995. Entrepreneurial Aspects of Privatisation in Transition Economies. **Europe-Asia Studies**, 47 (2), pp. 305-16.

DUNMAN, J., 1975. **Agriculture: Capitalist and Socialist: Studies in the development of agriculture and its contribution to economic development as a whole**. London: Lawrence and Wisehart.

DUCZKOWSKA-MALYSZ, K., & DUCZKOWSKA-PIASECKA, M., 1987. Information and Communication in Polish Agriculture: The Main Problems and Features. **Proceedings of the 15th Symposium of the European Association of Agricultural Economists**, 1988, pp. 231-36.

DZHIKIIA, I., 1986. An integrated Econometric Model for Forecasting Agricultural Production. **Matckon**, pp. 67-90.

DZIEMBOWSKA-KOWALSKA, J., 1996. East European News. **The Newsletter of the Regional Studies Association**, 202 (April).

Various issues. 1995. **East Europe Agriculture and Food**.

Various Issues. 1993-1996. **East European Markets**.

Return Flight from Never Never Land. 1991. **East European Reporter**, (Spring/Summer).

East European Agriculture. 1992, 14 (February).

EASTER, K., ABEL, M., & NORTON, G., 1977. Regional Differences in Agricultural Productivity in Selected Areas of India. **American Journal of Agricultural Economics**, 59 (May), pp. 257-65.

ECKERT, R.,& LEFTWICH, R., 1988. **The Price System and Resource Allocation**. 10th ed. N.Y.: The Dryden Press.

ECONOLYNX INTERNATIONAL Ltd, 1992. **Business Opportunities in Poland. A Guide To Agricultural Ventures**. Canada: Econolynx International Ltd.

EUROPEAN COMMISSION, ed., 1969. **Memorandum on the Reform of Agriculture in the Community**. Brussels: European Commission.

EUROPEAN COMMISSION, ed., 1993. **Die Lage der Landwirtschaft in der Gemeinschaft, Bericht 1993**. Brussels: European Commission.

EUROPEAN COMMISSION, ed., 1995. **Agricultural Situation and Prospects in the Central and Eastern European Countries. Summary Report. Working Document**. Brussels: European Commission.

EUROSTAT, 1987. **Farm Structure Survey: Main Results**. Luxembourg: Statistical Office of the European Communities.

EUROSTAT, 1995. **Statistics in Focus. Agriculture, Forestry and Fisheries**. Luxembourg: Statistical Office of the European Communities.

EVENSON, R., KISLEV, Y., 1975. **Agricultural Research and Productivity**. N.H.: Yale University Press.

FAN, S., 1991. Effects of Technological Change and Institutional Reform On Production Growth in Chinese Agriculture. **American Journal of Agricultural Economics**, (May), pp. 267-75.

FARRELL, M., 1957. The Measurement of Productive Efficiency. **Journal of Royal Statistics Society**, 120, pp. 253-81.

FEARNE, A., 1991. The History and Development of the CAP 1945-1985. **In: C. RITSON & D. HARVEY, eds., The Common Agricultural Policy and the World Economy**. Essays in Honour of John Ashton. Wallingford.

FEI, J., & RANIS, G., 1964. **Development of the Labour Surplus Economy: Theory and Policy**. IL.: Irwin Publishers.

FERREIRA, M., 1995. Liberalisation of East-West Trade. **Comparative Economic Studies**, 37 (2), pp. 71-96.

FISHER, I., 1967. **The Making of Index Numbers**. N.Y.: Augustus. M. Kelley.

FLEISHER, B., & LIU, Y., 1992. Economies of Scale, Plot Size, Human Capital, and Productivity in Chinese Agriculture. **Quarterly Review of Economic Finance**, 32 (3).

FLORKOWSKI, W., HILL, L., & ZAREBA, M., 1988. The Impact of Agricultural Policy Changes on Food Production in Poland. **Comparative Economic Studies**, 30 (3), pp. 16-32.

FULLER, A., & MAGE. J., 1976. **Part-time Farming. Problem or resource in rural development**. Norwich: Geo Abstracts Ltd.

FUSSELL, G., 1965. **Farming Techniques from Prehistoric to Modern Times**. Oxford: Pergamon.

GEMMA, M., 1989. **Reforming Polish Agriculture: Productivity Growth and Market Behaviour of Socialised and Private Farms**. PhD thesis. US: University of Minnesota.

GEORGE, D., 1988. **Mathematical Modelling for Economists**. London: MacMillan Press Ltd.

GHOSH, R., 1971. Some Experiments on an Aggregate Agricultural Production Function for Fifty Districts of India. **Economic Affairs**, 16, (1-2), January-February.

GIFFORD, A., & SANTONI, G. J., 1979. Public economics: politicians, property rights and exchange. Illinois: Dryden Press.

GILBERT, C., 1996. A model of US cereals food aid flows with an application to trade liberalisation. **Journal of Agricultural Economics**, 47 (2).

GOLDSMITH, A., 1995. Democracy, Property Rights and Economic Growth. **Journal of Development Studies**, 32 (2).

GORBACHEV, M., 1987-1989. **Izbrannye rechi i stat'i, 6 vols.** Moscow.

GORZELAK, G., 1996. **The Regional Dimension of Transformation in Central Europe**. London: Jessica Kingsley Publishers Ltd.

GRAVELLE, H., & REES, R., 1992. **Microeconomics**. 2nd Edition. London: Longamn.

GREENE, W., 1993. **Econometric Analysis**. N.Y.: Prentice-Hall International Inc.

GRIGG, D., 1974. **The Agricultural Systems of the World**. Cambridge: Cambridge University Press.

GRILICHES, Z., 1992. Sources of Agricultural Economic Growth and Productivity: Discussion. **American Journal of Agricultural Economics**, 74 (3).

GUJARATI, D., 1992. **Essentials of Econometrics**. N.Y.: McGraw-Hill Inc.

GLOWNY URZAD STATYSTYCZNY (GUS) (POLISH CENTRAL STATISTICAL OFFICE), 1987a. **Dziatalnosc Inwestycyjna w gospodarstce prywatnej [Czesc IV]**, p. 144. Warsaw: GUS.

GUS, 1987b. **Producjka Roslinna W 1987**, pp. 14, 17, 25, 31, 32, 36, 42, 47, 48, 67, 74, 77, 82 & 86. Warsaw: GUS.

GUS, 1988a. **Dziatalnosc Inwestycyjna w gospodarstce prywatnej [Czesc IV]**, pp. 14 & 15.

Warsaw: GUS.

GUS, 1988b. **Producjka Roslinna W 1988**, pp. 15, 18, 27, 30, 31, 34, 43, 46, 47, 66, 73, 76, 81 & 84. Warsaw: GUS.

GUS, 1988c. **Rocznik Statystyczny 1987**, p. 273. Warsaw: GUS.

GUS, 1988d. **Wyniki Spisu Roliczego, 1988**, pp. 29, 30, 31, 52, 56, 57, 69, 77, 93, 99 & 102. Warsaw: GUS.

GUS, 1989a. **Dzialalnosc Inwestycyjna w gospodarstce prywatnej [Czesc IV]**, p. 110. Warsaw: GUS.

GUS, 1989b. **Produkcja Podstawowych Upraw Rolnych Wedlug Wojewodztw I Grup Producentow W 1989**, pp. 18, 21, 30, 33, 37, 53, 56, 87, 89, 96, 99, 104 & 107. Warsaw: GUS.

GUS, 1989c. **Rocznik Statystyczny 1988**, pp. 191, 192 & 290. Warsaw: GUS.

GUS, 1989d. **Rolicza Produkcja Towarowa I Srodki Produkcji W Rolnictwie W 1989**. pp. 109 & 114. Warsaw: GUS.

GUS, 1989e. **Wyniki Spisu Roliczego, 1989**, pp. 27, 28, 29, 57, 58, 59, 88, 111 & 104. Warsaw, Poland.

GUS, 1989f. **Zatrudnienie I Wynagrodzenia W Rolnictwie w. 1988**, p. 9. Warsaw: GUS.

GUS, 1990a. **Dzialalnosc Inwestycyjna w gospodarstce prywatnej [Czesc IV]**, pp. 12 & 13. Warsaw: GUS.

GUS, 1990b. **Praca, 1990**, pp. 78 and 88. Warsaw: GUS.

GUS, 1990c. **Produkcja Podstawowych Ziemioplodow Rolnych Wedlug Wojewodztw I Grup Producentow w 1990**, pp. 14, 17, 26, 29, 30, 35, 42, 45, 70, 73, 77, 80, 85 & 88. Warsaw: GUS.

GUS, 1990d. **Rocznik Statystyczny 1989**, pp. 1 & 327. Warsaw: GUS.

GUS, 1990e. **Wyniki Spisu Roliczego, 1990**, pp. 27, 30, 31, 59, 62, 63, 72, 84, 91, 103 & 108. Warsaw: GUS.

GUS, 1991a. **Dziatalnosc Inwestycyjna w gospodarstce prywatnej [Czesc IV]**, pp. 12 & 13. Warsaw: GUS.

GUS, 1991b. **Produkcja Podstawowych Upraw Rolnych Wedlug Wojewodztw I Grup Producentow W 1991**, pp. 17, 20, 32, 35, 37, 52, 55, 87, 90, 95, 98, 105 & 108. Warsaw: GUS.

GUS, 1991c: **Rocznik Statystyczny 1990**, pp. 1 & 320. Warsaw: GUS.

GUS, 1991d. **Rolicza Produkcja Towarowa I Srodki Produkcji W Rolnictwie W 1991**, pp. 129 & 134. Warsaw: GUS.

GUS, 1991e. **Wyniki Spisu Roliczego, 1991**, pp. 59, 60, 61, 74, 86, 91, 98, 103 & 108. Warsaw: GUS.

GUS, 1992a. **Dziatalnosc Inwestycyjna w gospodarstce prywatnej [Czesc IV]**, p. 65. Warsaw: GUS.

GUS, 1992b. **Produkcja Podstawowych Upraw Rolnych Wedlug Wojewodztw I Grup Producentow W 1992**, pp. 13, 14, 22, 23, 25, 26, 34, 35, 56, 59 & 65. Warsaw: GUS.

GUS, 1992c. **Rocznik Statystyczny 1991**, pp. 1 & 308. Warsaw: GUS.

GUS, 1992d. **Rocznik Statystyczny Rolnictwa 1992**, pp. 36, 104, 105, 114, 115, 118, 167, 175, 204, 210, 218, 226, 227, 230, 231 & 236. Warsaw: GUS.

GUS, 1992e. **Rolicza Produkcja Towarowa I Srodki Produkcji W Rolnictwie W 1992**. pp. 129 & 134. Warsaw: GUS.

GUS, 1992f. **Rolnictwo Gospodarka Zywnosciowa, 1986-1990**, pp. 27, 72, 99, 104, 149, 139, 148, 149, 170, 173, 217, 220, 221, 235 & 240. Warsaw: GUS

GUS, 1992g. **Wyniki Spisu Roliczego, 1992**, pp. 82, 94, 100, 107, 113 & 118. Warsaw: GUS.

GUS, 1993a. **Dziatalnosc Inwestycyjna w gospodarstce prywatnej [Czesc IV]**, p. 71. Warsaw: GUS.

GUS, 1993b. **Information On Economic Situation in Poland in 1992**. Warsaw: GUS.

GUS, 1993c. **Produkcja Podstawowych Upraw Rolnych Wedlug Wojewodztw I Grup Producentow W 1993**. pp. 19, 24, 33, 38, 40, 45, 54, 59, 89, 96, 110 & 115. Warsaw: GUS.

GUS, 1993d. **Rocznik Statystyczny 1992**, pp. 1, 230, 236, 323 & 344. Warsaw: GUS.

GUS, 1993e. **Rolicza Produkcja Towarowa I Srodki Produkcji W Rolnictwie W 1993**, pp. 130 & 135. Warsaw: GUS.

GUS, 1993f. **Wyniki Spisu Roliczego, 1993**, pp. 72, 73, 84, 88, 93, 99 & 104. Warsaw: GUS.

GUS, 1994. **Rocznik Statystyczny 1993**, p. 1. Warsaw: GUS.

HARLAN, J., 1975. **Crops and Man**. Wisconsin: American Society of Agronomy.

HARTMANN, M., 1996. **CAP Reform: What Next? Implications of EU East Enlargement**

For the CAP. Paper presented at CREDIT Conference (26 March), University of Nottingham.

HARTOG, J., RIDDER, G., & THEEUWES, J., eds., 1990. **Panel Data and Labour Market Studies**. Amsterdam: North-Holland.

HATZIPROKOPIOU, M., KARAGIANNIS, G., & VELENTZAS, K., 1996. Production Structure, Technical Change, and Productivity Growth in Albanian Agriculture. **Journal of Comparative Economics**, 22 (3).

HAYAMI, Y., & RUTTAN, V., 1970. Agricultural Productivity Differences Among Countries. **American Economic Review**, 60 (5), pp. 895-911.

HAYAMI, Y., & RUTTAN, V., 1971, 1985. Agricultural Development: An International Perspective. 1st & 2nd eds. Baltimore (MD); London: John Hopkins University Press.

HAYNES, J., BUCKWELL, A., & COURBOIN, V., 1994. **The Consequences of the Uruguay Round for the Trade Preferences Accorded to the Countries of Central and Eastern Europe under the Europe and Interim Agreements. Final Report to DGI**. Brussels: European Commission.

HEADY, E., 1961. **Economics of Agricultural Production And Resource Use**. N.J.: Prentice-Hall Inc.

HEALEY, N., 1994. Doing Business with Eastern Europe: A Situational Analysis. **European Business Review**, 94 (3), pp. 3-8.

HEATHFIELD, D., & WIBE, S., 1987. **An introduction to cost and production functions**. London: MacMillan Education.

HOEN, H., 1996. Shock versus Gradualism in Central Europe Reconsidered. **Comparative Economic Studies**, 38 (1).

HORVATH, G., ed., 1993. **Development Strategies in the Alpine-Adriatic Region**. Centre of Regional Studies. Budapest: Hungarian Academy of Sciences.

HOUCK, J., 1992. The Comparative Advantages of Agricultural Economists. **American Journal of Agricultural Economics**, 74 (5).

HOWELL. 1994. Interview with Mr Paul Howell, Member of European Parliament, Conservative, Brussels.

HSIASO, C., 1986. **Analysis of Panel Data**. Cambridge: Cambridge University Press.

HUGHES, D., 1994. Interview with Mr David Hughes, Director of Agricultural Development Fund, British Government, Warsaw, MAF.

ILBERY, B., 1985. **Agricultural Geography, A Social and Economic Analysis**. Oxford: Oxford University Press.

ILBERY, B., 1986. **Western Europe: A Systematic Human Geography**, 2nd Ed. Oxford: Oxford University Press.

Various Issues. **International Financial Statistics**. Washington D.C.: International Monetary Fund.

ISLAM,T., & TASLIM, M., 1996. Demographic Pressure, Technological Innovation & Welfare: The Case of the Agriculture of Bangladesh. **Journal of Development Studies**, 32 (5).

JEFFERIES, I., 1993. **Socialist Economies and The Transition to the Market**. London; US; and Canada: Routledge.

JOHNSON, S., & BROOKS, K., 1983. **Prospects for Soviet Agriculture in the 1980s**. Bloomington IN: Indiana University Press.

JOHNSON, D., 1991. **World Agriculture in Disarray**. London: MacMillan Press Ltd.

JOHNSON, S., (et al) 1994. Production Efficiency and Agricultural Reform in Ukraine. **American Journal of Agricultural Economics**, 76, pp. 629-35.

JOHNSTON, B., & KILBY, P., 1975. **Agriculture and Structural Transformation**. Oxford: Oxford University Press.

JOHNSTON, J., 1984. **Econometric Methods**. 3rd Ed. London: McGraw Hill.

JONES, E., ed., 1967. **Agriculture and Economic Growth in England, 1650-1815**. London: Metheun.

JORGENSON, D., 1966. Testing Alternative Theories of the Development of a Dual Economy in Theory and Design of Economic Development. I., Adelman & E., Thorbecke, eds.

KARP, L., & STEFANOU, S., 1992. **Polish Agriculture in Transition: Does It hurt to be slapped in the face by An Invisible Hand?** Centre of Economic Policy and Research (Discussion Paper No. 622).

KARWAT-WOZNIAK, B., 1992. Mechanisation Services And Other Production-Related Services. Warsaw: Institute of Agricultural and Food Economics.

KASLIWAL, P., 1995. **Development Economics**. Ohio: South-Western Publishing.

KASRIEL, K., (et al) 1995. Engine fine, pilot missing. Poland Survey. **Business Central Europe** (February).

KAWAGOE, T., HAYAMI, Y., & RUTTAN. V., 1985. The Intercountry Agricultural Production Function and Productivity differences Among Countries. **Journal of Development Economics**, 19, pp. 113-32.

KAZMI, 1971. **Quarterly Journal of Institute of Developing Economies,** IX (4).

KENDRICK, J., 1961. **Capital in the American Economy: Its Formation and Financing.**

KENNEDY, P., 1994. **A Guide to Econometrics**. 3rd Ed. Oxford: Blackwell Publishers.

KENT, Y., 1994. Interview with Miss Yvonne Kent, Phare Programme Officer, Commission of the European Communities, (October). Warsaw.

KING, R., 1977. **Land Reform: a world survey**. London: Bell.

KING, R., & BURTON, S., 1982. Land Fragmentation: notes on a fundamental rural spatial problem. **Progress in Human Geography**, 6, pp. 476-94.

KISIEL, M., 1994. Interview with Dr Michal Kisiel, Institute of Agricultural and Food Economics, 12 October. Warsaw.

KLODZINSKI, M., 1992. **Processes of Agricultural Change in Eastern Europe. The Example of Poland**. Kent: Croom Helm Ltd.

KORCELLI, P., 1994. On Interrelations Between Internal and International Migration. **Innovation**, 7 (20), pp. 151-63.

KOOPMAN, R., 1989. Efficiency and Growth in Agriculture: A Comparative Study of the Soviet Union, United States, Finland and Canada. Department of Agriculture, Agricultural and Trade Analysis Division, USDA (Staff Report, no. 4, pp.89-154). Washington DC: USDA.

KORNAI, J., 1995. **Highways and Byways. Studies on Reform and Post-Communist Transition**. Cambridge, MA; & London: MIT Press.

KOSTROWICK, J., (et al) 1988. **Changes in the spatial structure of Polish agriculture: 1950-**

1970. Warsaw: Polska Akademia Nauk.

KOWALSKI, Z., 1993. Back to Market: Polish Family Farming in the 1990s. **Canadian Journal of Agricultural Economics**, 41, pp. 349-56.

KUBA, F., 1996. The Agro-food Sector in Transition. **The OECD Observer**, no. 197, (December 1995/January 1996).

KUMBHAKAR, S., 1987. The Specification of Technical And Allocative inefficiency in stochastic production and profit frontiers. **Journal of Econometrics.**

KWIECINSKI, A., & QUAISSER, W., 1993. Agricultural Prices and Subsidies In the Transformation Process of the Polish Economy. **Economic Systems**, 17 (2), (June), pp. 125-54.

KWIECINSKI, A., 1994. Interview with Director Andrzej Kwiecinski, Director of Agricultural Policy Analysis Unit, FAPA (12 October). Warsaw: MAF.

KWIECINSKI, A., 1994. **Poland by the year 2000: a realistic objective?** Agra-Europe Conference. June 1994. Warsaw

LaFRANCE, J., 1992. Environmental Policy and GATT Negotiations: Discussion. **American Journal of Agricultural Economics**, 74 (3).

LAI, S., 1991. A study of the changes of agricultural productivity induced by the chinese rural institutional reform-The Adoption of the Household Responsibility system. PhD Thesis for the Graduate Faculty of Political and Social Science of the New School for Social Research, US.

LAIRD, R., HAJDA, J., & LAIRD, B., 1977. **The Future of Agriculture in the Soviet Union and Eastern Europe. The 1976-1980 Five Year Plans**, US: Westview Press Inc.

LAU, L., & YOTOPOULOS, P., 1968. Do countries idiosyncrasies matter in estimating a production function for world agriculture? **Journal of Economic Development**, 13 (1), pp. 7-19.

LAU, L., & YOTOPOULOS, P., 1971. A test for relative efficiency and application to Indian Agriculture. **American Economic Review**, 61 (March), pp. 94-109.

LAVIGNE, M., 1995. **The Economics of Transition, From Socialist Economy to Market Economy**. London: MacMillan Press Ltd.

LEWIS, W., 1954. **Economic Development with Unlimited Supply of Labour**. Manchester: The Manchester Business School (May).

LICHTENSTEIN, P., 1996. A New-Institutionalist Story about the Transformation of Former Socialist Economies: A Recounting and an Assessment. **Journal of Economic Issues**, XXX (1), March, pp. 243-65.

LIN, Y., 1989. **Rural Reforms and Agricultural Productivity Growth in China**. UCLA. Working Paper no. 576. December.

LIPINSKI. 1993. Interview with Mr Lipinski, European Fund for Development of Polish Agriculture Warsaw: MAF.

LIPTON, M., 1984. Urban Biased Revisited. **Journal of Development Studies**, April.

LIU, A., YAO, S., & GREENER, R., 1996. A CGE model of agricultural policy reform in the Philippines. **Journal of Agricultural Economics**, 47 (1).

LOCKHEED, M., JAMISON, D., & LAU, L., 1972. Farmer education and farm efficiency: A survey. **Economic Development and Cultural Change**, 29 (1), pp. 37-76.

LONSDALE, R., & ENDEDI, G., eds., 1984. **Rural Public Services: International Comparisons**. Colorado: Westview.

LU, Y., 1975. Measuring Productivity Changes in the U.S. Agriculture. **Southern Journal Of Agricultural Economics**, (December), pp. 69-75.

LUTZ, E., 1992. Trade and Environment: Discussion **American Journal of Agricultural Economics**, 74 (5).

MADDALA, G., 1987. Recent Developments in the Econometrics of Panel Data Analysis. **Transportation Research**, 21, pp. 303-26.

MADDALA, G., 1987: Limited dependent variable models using panel data. **The Journal of Human Resources**, 22, pp. 307-38.

MADDALA, G., 1993. **The Econometrics of Panel Data, Vols. I and II**. Cheltenham: Edward Elgar Publishing.

MADDISON. A. 1970. **Economic Progress and Policy in Developing Countries.** London: Allen and Unwin.

MAF, 1992. **The Polish Agriculture and Food Economy, Overview**. Warsaw: MAF.

MAF, 1993. **Agricultural Extension Service Centres in Poland. The Guide Book 1993**. Poznan: MAF.

MAF, 1994. **Concept of Social and Economic Policy for rural, agricultural and food economy sectors till year 2000**. Warsaw: MAF.

MANTEUFFEL, R., 1982. Socio-Economic Sectors in Polish Agriculture and their Effectiveness. **Acta Academia Scientiarum Polonae**, 8.

MATYAS, L., 1992. Modelling panel data. **Structural Change and Economic Dynamics**, 3, pp. 291-384.

MATYAS, L., & SEVESTRE, P., eds., 1992. **The Econometrics of Panel Data: handbook of theory and applications**. Dordedrecht: Kluwer Academic Publishers.

MERRIDALE, C., & WARD, C., 1991. **The Historical Perspective Perestroika**. London: Edward Arnold.

MESSERLIN, P., 1993. The Association Agreements between the EC and Central Europe: Trade liberalisation versus Constitutional Failure. **Acta Oeconomica**, 45 (1-2), pp. 119-44.

McGUIRK, S., & MUNDLAK, Y., 1992. The Transition of Punjab Agriculture: A Choice of Technique Approach. **American Journal of Agricultural Economics**, 74 (1).

MEEUSEN, W., & BROECK, J. van der, 1977. Efficiency estimation from Cobb Douglas production functions with composed error. **International Economic Review**, 18, 435-44.

MOLL, P., 1988. Comment. **Journal of Development Economics**, 28 (1), pp. 121-24.

MOYER, H., & JOSLING, T., 1990. Agricultural Policy Reform-Politics and Process in the EC and the USA. New York; London; Toronto; Sydney; Tokyo.

MUCHA-ORLINSKA, I., 1994. Interview with Miss Isabella Mucha-Orlinska, State Property Agency, 21 November. Warsaw MAF.

MUNCH, W., 1994. Transformation und Agramarkte in den Visegrad-Staaten. Diplomarbeit, Fachbereich Agrarwissenschaften der Universitat Gottingen. Gottingen.

MUNDLAK, Y., 1963. Estimation of Production and Behavioural Functions from a Combination of Cross-Section and Time-Series Data. **In C., CHRIST (et al), 1963. Measurement in Economics: Essays in Mathematical Economics and Econometrics**. In Memory of Yehuda Grunfeld. Stanford: Stanford University Press.

MUNDLAK, Y., & HOCH, I., 1965. Consequences of Alternative Specifications in Estimation of Cobb Douglas Production Functions. **Econometrica,** 33 (4), October, pp. 814-28.

MUNDLAK, Y., & HELLINGHAUSEN, R., 1982. The intercountry agricultural production function: Another view. **American Journal of Agricultural Economics**, 64 (4), pp. 664-72.

NALLET, H., & STOLK, A., van, 1994. Relations between the European Union and the Central and Eastern European Countries in Matters concerning Agriculture and Food Production. Paper prepared for DG VI of the Commission of the European Union. June 15.

NELSON. R. 1964. Aggregate Production Functions and Medium Range Growth Projections. **American Economic Review**, September.

NEVIN, E., 1990. **The Economics of Europe**. London: MacMillan.

NIEMCZYK, J., 1993. Main Aspects of Integration of Polish Agriculture into the EEC. Paper prepared for the Conference on 'Policy Options for Polish Agriculture', for the Foundation for the Development of Polish Agriculture. Warsaw. 22-24 April.

NOWAK, R., 1993 & 1994: Interview with Madam Nowak, Agricultural Advisor for Lodz, Skierniewice and Piotakowskie voivodships (counties), July.

NOWICKI, M., 1992. Environment in Poland. Publication was produced within the framework of the EEC PHARE Programme of environmental assistance in Poland, and forms part of Poland's contribution to the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, 1992.

NGUYEN, D., 1979. On agricultural productivity differences among countries. **American Journal of Agricultural Economics**, 61 (30), pp. 565-70.

OECD. 1994a. **Review of Agricultural Policies: Hungary**. Paris: OECD.

OECD. 1994b. **Agricultural Policies, Markets and Trade. Monitoring and Outlook 1994 in the Central and Eastern European Countries, the New Independent States, Mongolia and China**. Paris: OECD.

OECD, 1995a. **World Development Report, 1995**. World Bank: Oxford University Press.

OECD, 1995b. **Labour force Statistics, 1973-1993**. Paris: OECD.

OSTROWSKI, L., 1992a. **Technical And Social Infrastructure, Trade And Service Network In Agricultural Areas, Surveyed by IAFE in 1992**. Warsaw: Institute of Agricultural and Food Economics.

OSTROWSKI, L., 1992b. **Housing Standard of the Rural Population in 1992**. Warsaw: Institute of Agricultural and Food Economics.

OSTROWSKI. L. 1992c. **Farms Managed by Women (the results of IAFE survey conducted in 1992)**. Warsaw: Institute of Agricultural and Food Economics.

OSTROWSKI, L., 1992d. **Bank Credits Granted To Farmers Results of Survey-1992.** Warsaw: Institute of Agricultural and Food Economics.

PACIONE, M., 1986. **Progress in Agricultural Geography**. Kent: Croom Helm Ltd.

PARIKH, J., ed., 1988. **Sustainable Development in Agriculture. International Institute of Applied Systems Analysis**. Netherlands: Martinus Nijhoff Publishers.

PASOUR, E., Jr., 1981. A further note on the measurement of efficiency and economics of farm size. **Journal of Agricultural Economics**, XXXII (2).

PEROTTI, E., 1993. Bank lending in transition economies. **Journal of Banking and Finance**, 17, pp. 1021-32.

PETIT, M., (et al) 1987. Agricultural Policy Formation in the European Community: The Birth of Milk Quotas and CAP Reform. Amsterdam.

PIESSE, J., THIRTLE, C., & ZYL, J., van, 1996. Effects of the 1992 Drought on productivity in the South African Homelands: An application of the Malmquist Index. **Journal of American Economics**, 47 (2).

POLISH HEARTH CLUB CONFERENCE. 1995: London, June.

PORTER, M., 1990. **The Competitive Advantage of Nations**. London: MacMillan.

PORTUGAL, L., 1995. Restructuring Polish Agriculture. **The OECD Observer**, No. 192, (February/March).

POTTER, C., & LOBLEY, M., 1996. The Farm Family Life Cycle, Succession Paths and Environmental Change in Britain's Countryside. **Journal of Agricultural Economics**, 47 (2).

POZNANSKI, K., ed., 1995. **The Evolutionary Transition to Capitalism**. Colorado: Westview Press.

PREEG, E., 1995. **Traders in a brave new world: The Uruguay Round and the future of the international trading system**. Chicago; London: University of Chicago Press.

PUGH, G., 1993. The Economics of German Unification. The Economic Impact of Unification on Germany, the EC and, in particular the UK. Greenwich Papers (formerly Thames Papers) in Political Economy. No. 1 (Summer).

RAO, V., & CHOTIGEAT, T., 1981. The Inverse Relationship between Size of Land Holdings and Agricultural Productivity. **American Journal of Agricultural Economics**. 63 (3), pp. 571-74.

RAYNER, A., & INGERSENT, K., 1991. Institutional and Technical Change in Agriculture. **In V. BALASUBRAMANYAM, & L. SANJAYA eds., 1991. Current Issues in Agricultural Economics**. London: Macmillan Education Ltd, pp. 23-49.

REED. F., 1994. Interview with Ms Reed, Commission DG VI, Agriculture, Brussels.

REUTER, 1994, 1995 & 1996.

RIZZO, M., ed., 1979. **Time, Uncertainty and Disequilibrium**. UK: Lexington.

ROBERTS, D., FROUD, J., & FRASER, R., 1996. Participation in Set-aside: What determines the opting in price? **Journal of Agricultural Economics**, 47 (1).

ROBINSON. S. 1971. The Sources of Growth in Less Developed Countries: A Cross-Section Study. **Quarterly Journal of Economics**, August.

ROWINSKI, J., 1991. Current and Future Trade Prospects with the EC, Working Paper No.3. Agricultural Price and Trade Policy and Agricultural Budget, Agricultural Sector Adjustment Loan Supporting Volumes, Volume 1. Warsaw: MAF.

ROWINSKI, J., 1993. Agriculture in the Process of Integration with the EEC. Paper prepared for the Conference on 'Policy Options for Polish Agriculture', for the Foundation for the Development of Polish Agriculture. Warsaw. 22-24 April.

ROWINSKI, J., 1994. Interview with Dr Janusz Rowinski, Institute of Agricultural and Food Economics, 20 October, Warsaw.

ROSTOWSKI, J., 1993. The Implications of Rapid Private Sector Growth In Poland. Discussion Paper No. 159. LSE, Centre for Economic Performance. July.

RUTTAN, V., 1982. **Agricultural Research Policy**. Minneapolis: University of Minnesota Press.

ROZWADOWSKI, R., 1991. Land Policy and State Farm Restructuring, Working Paper No.13. Land Policy and Privatisation and Restructuring of State Farms, Agricultural Sector Adjustment Loan Supporting Volumes, Volume IV. Warsaw: MAF.

RYGNESTAD, H., & FRASER, R., 1996. Land Heterogeneity And the Effectiveness of CAP Set-aside. **Journal of Agricultural Economics,** 47 (2).

SACHS, J., 1992. The Economic Transformation of Eastern Europe: The Case of Poland. **The American Economist.** 36 (2).

SANTORUM, A., 1994. Interview with Dr Anita Santorum, Consultant for ASAP, FAPA, responsible for World Bank assistance, 12 October. Warsaw, MAF.

SAXBY, R., 1996. Interview with Mr Richard Saxby, Farm Office, Brackenhurst College, Nottinghamshire.

SCHAMEL, G., 1991. The Agricultural and Food Economy and its Trade Relations with the European Community, Working Paper no.4. Agricultural Price and Trade Policy and Agricultural Budget, Agricultural Sector Adjustment Loan Supporting Volumes, Volume 1. Warsaw: MAF.

SCHUH, G., 1980. Comment. **In J. KENDRICK & B. VACCARA, eds., 1980. New Developments in Productivity Measurements**, pp. 585-94. Chicago: University of Chicago Press.

SCHUH, G., 1991. Open Economies: Implications for Global Agriculture. **American Journal of Agricultural Economics,** 73 (5).

SHARIF, N., & DAR, A., 1996. An Empirical Study of the Patterns & Sources of Technical Inefficiency in Traditional and HYV Rice Cultivation in Bangladesh. **Journal of Development**

Studies, 32 (4).

SHEN, R., 1992. **The Polish Economy. Legacies from the Past, Prospects for the Future**. N.Y.: Praeger Publishers.

SIKORSKA, A., 1992. **Selected Problems Of The Labour Market In Rural Area**, Warsaw: Institute of Agricultural And Food Economics.

SIMATUPANG, B., 1983. Polish Agriculture in the 1970s and the Prospects of the Early 1980s. **European Agricultural Economics Review**, 8.

SLAY, B., 1994. **The Polish Economy. Crisis, Reform and Transformation**. N.J.: Princeton University Press.

SMITH, V., 1992, Environmental Costing for Agriculture: Will It be Standard Free in the Farm Bill of 2000? **American Journal of Agricultural Economics**, 74 (5).

SMITH, A., 1994. Interview with Mr Andrew Smith, Commercial Attache, British Embassy, 4 October, Warsaw.

SOLOW, R., 1957. Technical Change and The Aggregate Production Function. **Review of Economics and Statistics**, 39, pp. 312-22.

SOLOW.R. 1960: **Investment and Technical Progress in Mathematical Methods in the Social Sciences**, ed. K. Arrow, S. Karlin and P. Suppes. Stanford University Press.

The Spectator. 1993.

STABLER, M., 1975. **MacMillan Studies in Economics. Agricultural Economics and Rural Land-use**. London: MacMillan Press Ltd.

STUART, R., & GREGORY, P., 1995. **The Russian Economy. Past, Present and Future.** N.Y.: Harpercollins College Publishers.

SWANN, D., 1990. **The Economics of the Common Market**. 6th ed. London: Penguin Books.

SYROP, K., 1976. **Spring in October. The Story of the Polish Revolution 1956.** Connecticut: Greenwood Press.

SZAFARZ, I., 1991. Trade Prospects with Central and Eastern European Countries And The Soviet Union, Working Paper No.5. Agricultural Price and Trade Policy and Agricultural Budget, Agricultural Sector Adjustment Loan Supporting Volumes, Volume 1. Warsaw: MAF.

SZCZYPIORSKI, A., 1981. **The Polish Ordeal. The View from Within.** Great Britain: Biddles Ltd.

SZEMBERG, A., 1992a. Agrarian Changes In 1988-1992 (Preliminary Results Of Survey), Warsaw: Institute of Agricultural Economics.

SZEMBERG, A., 1992b. Sources Of Living In Farmer Families. Warsaw: Institute of Agricultural Economics.

SZEMBERG, A., 1992c. Investment Activity Of Farmers And Technical Equipment Of Farms. Warsaw: Institute of Agricultural Economics.

SZEMBERG, A., 1992d. Population And Labour On Farms. Warsaw: Institute of Agricultural Economics.

SZEMBERG, A., 1994. Interview with Professor Anna Szemberg. Warsaw: Institute of Agricultural and Food Economics (18 October).

TANGERMANN, S., 1993. Outlook for Agriculture In Europe within Global Perspectives. Paper prepared for the Conference on 'Policy Options for Polish Agriculture' of the Foundation for the Development of Polish Agriculture. 22-24 April, Warsaw.

TANGERMANN, S., JOSLING. T., & MUNCH. W. 1994. Pre-accession agricultural policies for central Europe and the European Union. Final Report. Brussels: European Commission.

TANGERMANN, S., 1996. CAP Reform: What Next? An Ex-Post Review of The MacSharry Reform. Paper presented at the CREDIT Conference, 26 March, University of Nottingham.

THIRWALL. 1978. **Growth and Development**. 2nd Edition. London: MacMillan Press Limited.

THIRWALL, A., 1994. **Growth and Development**. 5th Ed. London: Macmillan Education Ltd.

THOMAS, R., 1993. **Introductory Econometrics: Theory and Applications**. N.Y.: Longmans Group UK Ltd.

TOPOLSKI, J., 1986. **An Outline History of Poland**. Warsaw: Interpress.

TRACY, M., 1982. **Agriculture in Western Europe. Challenge and Response. 1880-1980**. 2nd Ed. London.

TRUEBLOOD, M., 1989. Agricultural Production Function Estimates from Aggregate Intercountry Observations: A Selected Survey. **Canadian Journal of Agricultural Economics**, 37, pp. 1045-60.

TURNOCK, D., 1978. **Studies in Eastern Geography: Eastern Europe**. Great Britain: Unwin Brothers Ltd.

ULVELING, E., & FLETCHER, L., 1970. A Cobb Douglas Production Function with Variable Returns To Scale. **Journal of American Agricultural Economics**, 52 (2), pp. 322-26.

UN World Statistics. Geneva: United Nations.

ZON, H., van, 1992. Alternative Scenarios for Central Europe. **Futures.** June 1992.

VENN, J., 1933. **The Foundations of Agricultural Economics together with an economic history of British agriculture during and after the Great War**. London: Cambridge University Press.

VOGELER, I., 1981. **The Myth of the Family Farm**. US: Westview Press.

WIERCZOREK. 1994. Interview with Counsellor Wierczorek at the Polish Mission to the EC, Brussels.

WITZKE, H., von, 1993. Economic Transition and Polish Agriculture. Paper prepared for the Conference on 'Policy Options for Polish Agriculture', for the Foundation for the Development of Polish Agriculture. Warsaw, 22-24 April.

WEISSKOPF, T., BOWLES, S., & GORDON, D., 1983. **Hearts and Minds: A Social Model of US Productivity Growth**. Washington: Brookings Papers on Economic Activity, 1983. The Brookings Institution.

WHITBY, M., & ADGER, W., 1996. Natural and Reproducible Capital and the Sustainability of Land use in the UK. **Journal of Agricultural Economics**, 47 (1).

WINIECKI, J., 1992. The Polish Transition Programme: Underpinnings, Results, Interpretations. **Soviet Studies,** 44 (5).

WONG, L., 1986. **Agricultural Productivity in the Socialist Countries**. Colorado: Praeger Publishers.

WONG, L., & RUTTAN, V, 1983. Sources of Differences in Agricultural Productivity Growth

Among Socialist Countries. Paper presented at the Fifth Annual Conference on Current Issues in Productivity. Rutgers University, Newark, N.J., 5-7 December.

WONNACOTT, T., & WONNACOTT, R., 1990. **Econometrics.** 5th Ed. N.Y.: John Wiley & Sons.

WORLD BANK, 1990. **Country Study: Poland-Economic Management Export Development Project**. Washington DC: World Bank.

WORLD BANK. 1991. World Bank Development Report. Washington.

WOS, A., 1988. **The Reforming of the Agricultural Policy in Poland**. Agriculture and Governments in An Interdependent World, 20th International Conference of Agricultural Economists, Hants: Dartmouth Publishing Co.

WOS, A., 1993. Interview with Professor Wos, Institute of Agricultural Economics. Foundation for Development of Polish Agriculture. Warsaw. 6 July.

WU, D., 1975. Estimation of the Cobb Douglas Production Function. **Econometrica**, 43 (4).

YAMADA, S., & RUTTAN, V., 1980. International comparison of productivity in agriculture. **In J. KENDRICK & B. VACCARA eds., 1980. New Developments in Productivity Measurements**, pp. 509-85. Chicago: University of Chicago Press.

YAO, S., 1993. **The Determinants of Cereal Crop Productivity of the Peasant Farm Sector in Ethiopia, 1981-1987**. University of Portsmouth, Department of Economics, Discussion Paper no. 30.

YARON, D., DINAR, A., & VOET, H., 1992. Innovations on Family Farms: The Nazareth Region in Israel. **Journal of Agricultural Economics**, 74 (2), May.

YORGASON, V., & SPEARS, D., 1971. The Canadian Agricultural Production Function. **Canadian Journal of Agricultural Economics**, 19 (1), pp. 66-76.

YOTOPOULOS, P., 1968. On the Efficiencies of Resource Utilization In Subsistence Agriculture. **Food Research Institute Studies**, 2 (2), pp. 125-35.

YOTOPOULOS, P., & NUGENT, J., 1976. **Economics of Development**. N.Y.: Harper and Row.

ZELLNER, A., KMENTA, Y., & DREZE, B., 1966. Specification And Estimation of Cobb Douglas Production function models. **Econometrica**, 34 (4).

ZELLNER, A., & RICHARD, J., 1973. Use of Prior Information In The Analysis and Estimation of Cobb Douglas Production Function Models. **International Economics Review**, 14 (1), February.

ZUBERI, M., 1990. Institutional Credit on Agricultural Productivity under a Balanced Growth Programme. **Journal of Economic Development**, 75 9 (1), June.

Appendix I

Polish Secondary Agricultural Data (1988-1993)

Private sector data. by voivodship (county)[560]

1	$Output_t$	Cap_{t-1}	Lab[561]	Land	Inputs (kgs. per hectare)	Rainfall
1987	687.6					
1988	666.4	10.8	73.0	57.8	248.1	476
1989	665.3	11.9	64.7	81.2	268	480.4
1990	670.8	12.7	59.8	79.7	212.3	456
1991	592.3	13.0	54.9	75.2	125.7	482
1992	471.2	13.0	50.0	72.3	80.4	484.3
1993	688.8	13.2	50.0	74.9	89.1	454
2						
1987	1679.6					
1988	1274.8	18.6	78.9	130.0	178.2	424
1989	1659.3	20.7	74.2	179.5	167.1	424
1990	1543.3	22.0	70.1	180.1	122.3	541.4
1991	1282.3	22.6	66.0	177.7	64.6	482.2
1992	1225.0	22.6	62.0	174.7	71.4	536.3
1993	1359.6	22.9	62.0	172.6	96.3	487
3						
1987	1813.3					
1988	1459.7	28.0	122.8	174.1	167.5	530
1989	1634.6	30.4	114.0	223.7	190.6	424.3
1990	1603.1	32.1	109.0	223.4	148.3	621
1991	1400.8	33.0	104.0	215.0	54.3	536.1
1992	1261.4	33.1	99.0	203.4	49.6	617.4
1993	1495.0	33.6	99.0	210.7	95.2	586
4						
1987	505.5					
1988	477.8	127.0	100.4	44.3	361	981.6
1989	432.7	13.4	90.9	63.3	442.5	981.6
1990	515.6	14.1	88.1	60.9	336.2	836.3
1991	412.8	14.5	85.4	58.9	275.8	857.4
1992	411.7	14.6	82.6	56.6	162	742.7
1993	484.8	14.8	82.6	58.5	125.4	738

[560]The northwest includes 5, 9, 10, 11, 13, 16, 17, 21, 29, 32, 39, 41, 44, 46 and 49; the northeast includes 1, 4, 7, 23, 26, 28 and 40; the southwest includes 3, 8, 12, 14, 18, 20, 24, 27, 30, 31, 37, 38, 45 and 47. The southeast includes 2, 6, 15, 19, 22, 25, 33, 34, 35, 36, 42, 43, and 48.

[561]Data is intrapolated for years 1990 and 1991 (see 5.4.1).

5						
1987	2005.5					
1988	1971.1	27.8	96.1	189.9	402.3	353
1989	1480.9	29.6	79.9	227.1	534.1	353
1990	2297.2	31.5	74.4	222.6	516.8	560.4
1991	1670.1	32.3	69.0	216.9	529.4	518.6
1992	1168.6	32.4	63.5	217.4	531.4	483.4
1993	2152.1	32.8	63.5	219.5	375.7	606
6						
1987	872.8					
1988	702.7	9.5	54.1	88.0	228.8	443.2
1989	968.6	10.8	50.5	105.2	203	443.2
1990	887.1	11.4	49.7	109.1	145.9	496.8
1991	677.2	11.7	48.8	105.2	53.0	457.7
1992	724.1	11.7	48.0	107.6	62.8	516.8
1993	808.8	11.9	48.0	109.7	66.8	447
7						
1987	1998.4					
1988	1854.8	21.2	94.0	173.6	203.3	460.2
1989	1822.4	23.4	86.0	224.3	274.8	460.2
1990	1847.6	24.8	84.3	220.8	226.2	543.5
1991	1493.1	25.5	82.7	214.9	89.9	389.2
1992	1376.1	25.6	81.0	215.0	154	534.7
1993	1952.6	25.9	81.0	224.4	141.4	620
8						
1987	1419.8					
1988	1252.0	18.3	113.3	121.7	222.2	543
1989	1208.2	19.6	100.2	168.7	315.4	401.1
1990	1240.8	20.8	93.5	165.6	278.4	537.4
1991	1117.4	21.4	86.7	164.2	58.6	551.2
1992	921.7	21.4	80.0	164.5	85.6	550.1
1993	1271.0	21.7	80.0	168.2	132.2	602
9						
1987	625.1					
1988	573.1	12.5	41.6	76.3	411.4	581.5
1989	690.0	13.6	33.4	86.3	539.2	581.5
1990	863.1	14.3	33.9	91.4	405.5	749.4
1991	590.9	14.7	34.5	89.0	401.7	651.2
1992	606.9	14.8	35.0	84.1	403.4	692.9
1993	762.4	15.0	35.0	98.6	318.4	774
10						
1987	965.8					
1988	963.5	15.6	74.8	102.9	435.4	556
1989	1017.3	16.5	60.0	132.8	463.1	441.8
1990	1071.8	17.5	58.3	135.8	461.7	641.8
1991	886.7	18.0	56.7	132.6	278.7	600.6
1992	635.5	18.0	55.0	129.5	153.6	375.7
1993	997.6	18.3	55.0	139.6	129.0	432

11						
1987	555.1					
1988	543.7	9.9	46.2	70.7	432.2	538
1989	550.2	10.8	35.5	82.4	496.1	395.8
1990	611.9	11.5	33.7	81.5	470.5	519.4
1991	508.4	11.8	31.8	80.8	286	400.5
1992	314.2	11.8	30.0	74.2	198	430.9
1993	603.5	12.0	30.0	79.6	225.6	595
12						
1987	377.4					
1988	229.9	7.2	36.4	42.1	222.9	643
1989	349.2	8.0	30.4	51.2	335.3	571.6
1990	348.4	8.5	26.8	51.9	230.4	462
1991	332.1	8.7	23.1	53.3	93.1	548.8
1992	274.7	8.8	19.5	50.5	92.8	507.8
1993	369.3	8.9	19.5	52.0	110.3	707
13						
1987	2123.1					
1988	2003.2	26.3	34	154.7	401.6	442
1989	1966.3	27.8	98.7	204.7	456.9	318.8
1990	1977.1	30.1	98.1	195.3	321.9	399.1
1991	1855.1	30.9	97.5	201.3	130.7	439.9
1992	1220.7	31.0	96.9	202.3	114.6	392.3
1993	2248.6	31.4	97.0	204.1	126.7	574
14						
1987	1147.3					
1988	1094.8	20.7	105.8	92.7	337.2	644
1989	1039.2	21.6	116.5	126.2	398.9	539.7
1990	1128.6	22.9	96.0	122.1	367.5	688.4
1991	984.0	23.6	75.5	124.3	253.7	645.9
1992	815.9	23.6	55.0	119.3	243.4	595
1993	1124.5	24.0	55.0	125.8	163.4	515
15						
1987	2235.2					
1988	2049.3	27.3	146.6	237.6	195.7	601
1989	2022.9	29.6	206.1	311.0	223.2	598.9
1990	2375.0	31.5	207.4	300.3	178.6	711.7
1991	1902.2	32.3	208.6	297.5	60.9	483.1
1992	1507.8	32.4	209.9	295.0	41.2	586.3
1993	2161.0	32.8	210.0	305.7	157.7	561

16						
1987	1759					
1988	1644.4	18.3	88.8	153.2	248.9	306.7
1989	1311.6	19.6	81.8	198.2	282.8	306.7
1990	1629.7	21.2	77.5	195.0	230.6	455.5
1991	1491.6	21.8	73.3	192.3	80	521.8
1992	950.7	21.8	69.0	190.7	93.8	435.9
1993	1845.7	22.1	69.0	194.8	77.3	626
17						
1987	588.9					
1988	501.9	9.4	37.3	66.7	482.2	713
1989	578.3	10.2	28.8	82.6	517.9	603.7
1990	520.7	10.8	26.9	82.6	422.8	708.8
1991	364.1	11.1	24.9	78.8	312.8	860.4
1992	237.1	11.1	23.0	77.1	335.6	652
1993	435.7	11.3	23.0	93.9	106.0	812
18						
1987	778					
1988	735.5	15.6	125.1	79.9	307.4	646
1989	672.1	16.2	116.3	107.2	189.8	667.8
1990	816.4	17.1	109.5	104.1	309.9	645.7
1991	639.2	17.6	102.8	101.8	203.6	624.3
1992	576.3	17.6	96.0	99.8	176.3	517.6
1993	758.1	17.9	96.0	101.2	328.4	470
19						
1987	593.1					
1988	556.3	11.9	96.8	52.4	207.2	757.7
1989	516.2	12.8	90.0	75.8	207.7	757.7
1990	614.8	13.6	87.0	76.0	191.1	694.4
1991	491.3	14.0	84.0	72.4	73	683.7
1992	488.3	14.1	81.0	67.8	47.6	743.1
1993	591.5	14.2	81.0	67.3	134.5	626
20						
1987	716					
1988	457.4	10.8	38.6	71.5	483.8	414.5
1989	698.6	11.6	32.2	86.0	505.9	414.5
1990	727.3	12.3	29.5	83.1	425.3	407.7
1991	703.3	12.6	26.7	85.9	352.6	395.5
1992	569.2	12.6	24.0	83.8	201.1	407.6
1993	885.7	12.8	24.0	84.9	151.7	512
21						
1987	1122.4					
1988	1032.8	16.7	52.8	77.2	497.4	392.1
1989	996.5	17.7	44.2	98.4	502:1	392.1
1990	1115.0	18.8	43.5	92.6	470.3	567.6
1991	858.6	19.3	42.7	89.6	389.3	482.3
1992	577.8	19.4	42.0	90.2	282.2	395.6
1993	1109.0	19.6	42.0	91.1	193.3	650

22						
1987	2929.2					
1988	1761.6	27.4	170.6	210.5	246.2	523
1989	2876.7	29.0	160.8	272.5	270.1	540.7
1990	2776.3	30.8	158.2	271.9	203.1	614.9
1991	2153.4	31.6	155.5	266.1	133.6	446
1992	2064.9	31.7	152.9	265.1	134.4	667.8
1993	2529.7	32.1	153.0	269.4	169.4	446
23						
1987	1857.3					
1988	1661.4	25.3	97.3	142.5	176	530
1989	1815.1	27.4	93.4	202.1	195.2	424.3
1990	1782.4	29.1	91.4	200.3	144.9	621
1991	1551.2	29.9	89.3	194.5	86.9	536.1
1992	1566.2	30.0	86.0	197.4	78.5	617.4
1993	1784.7	30.4	86.0	198.3	129.7	586
24						
1987	406.9					
1988	359.0	5.3	34.0	34.9	378	538
1989	348.3	5.6	29.5	47.0	346.9	460.8
1990	363.2	5.9	28	47.4	243.7	509.3
1991	325.0	6.1	26.5	46.3	216.6	450.5
1992	208.6	6.1	25.0	44.9	258.9	447.2
1993	376.1	6.2	25.0	45.6	160.5	579
25						
1987	665.6					
1988	588.4	15.9	127	61.2	298.4	670
1989	500.1	17.2	145.2	90.0	232.1	819.5
1990	625.5	18.2	151.1	80.9	183	683.2
1991	437.4	18.7	157	78.9	79.6	673.9
1992	538.8	18.7	162.9	76.9	83.2	596.9
1993	610.8	19.0	163.0	79.9	91.8	574
26						
1987	1011.7					
1988	797.6	17.5	71.3	105.0	257.5	625
1989	896.4	19.4	55.7	127.7	296.2	585
1990	976.0	20.6	51.8	131.1	289.7	594.2
1991	802.7	21.1	47.9	130.8	185.2	500.2
1992	562.6	21.2	44.0	122.1	160.9	626.6
1993	907.4	21.5	44.0	137.2	143.8	684
27						
1987	1926.7					
1988	1871.0	30.7	124.3	153.3	514.9	644
1989	1791.6	32.0	83.2	183.0	618.7	539.7
1990	1746.5	33.9	75.1	183.7	485.9	688.4
1991	1669.4	34.9	67.1	181.1	333.7	645.9
1992	1367.2	34.9	59.0	179.8	265.7	595
1993	1931.0	35.4	59.0	186.1	245.5	515

28						
1987	1351.8					
1988	1202.1	16.1	93.7	145.8	166.6	542
1989	1239.9	18.6	88.7	194.7	228.1	503
1990	1239.4	19.7	82.8	186.6	167.6	561.3
1991	1146.6	20.2	76.9	187.0	115.2	491.3
1992	902.5	20.3	71.0	186.2	88.5	544.2
1993	1247.1	20.5	71.0	186.1	127.2	620
29						
1987	876.2					
1988	814.1	14.1	46.5	90.1	338.2	382.6
1989	789.9	15.2	38.8	112.1	399.5	382.6
1990	915.9	16.2	38.5	111.8	379.5	603
1991	750.3	16.7	38.3	110.4	204.1	480.3
1992	420.4	16.7	38.0	114.1	257.9	342.5
1993	901.4	16.9	38.0	139.4	128.7	558
30						
1987	2550.5					
1988	1481.4	17.5	112.2	146.7	272.4	498.7
1989	1438.9	19.3	104.6	204.0	297.6	498.7
1990	1546.1	20.5	102.7	198.9	217.3	514
1991	1394.9	21.0	100.7	203.1	76.1	413.6
1992	1023.0	21.1	98.9	203.4	112	471
1993	1602.3	21.4	99.0	206.8	98.7	495
31						
1987	1998.8					
1988	2004.2	22.8	100.4	171.7	359.8	368.9
1989	1969.6	24.5	90.6	210.0	343.4	368.9
1990	1915.8	26.0	84.7	203.9	253.8	471.3
1991	1668.7	26.7	78.9	201.1	182	418.3
1992	1371.4	26.8	73.0	200.1	42.8	437.3
1993	2128.3	27.2	73.0	202.4	51.7	512
32						
1987	1674.2					
1988	1644.1	25.4	80.5	140.7	452.6	523
1989	1488.4	27.1	65.1	170.5	549.0	335.2
1990	1775.0	28.8	63.2	169.7	561.8	524.4
1991	1437.3	29.6	61.4	164.6	572.6	418.4
1992	950.2	29.6	59.5	161.8	432.9	355.2
1993	1833.3	30.0	59.5	172.8	348.8	695
33						
1987	924.5					
1988	1003.1	12.0	87.7	81.4	215.8	583.4
1989	883.4	13.1	81.3	102.1	244.3	583.4
1990	1007.5	13.8	76.9	100.7	197.5	651.9
1991	780.5	14.2	72.4	100.5	144.4	668.1
1992	836.0	14.3	68.0	100.4	123.5	625.2
1993	891.0	14.5	68.0	102.4	90.6	523

34						
1987	1876.8					
1988	1725.5	23.6	154.1	193.7	228.3	472.4
1989	1738.7	25.8	146.3	258.6	228.8	472.4
1990	1754.3	27.3	139.2	256.9	224.9	471.4
1991	1538.8	28.1	132.0	253.8	192.5	412.2
1992	1161.6	28.1	124.9	252.1	111.9	594.6
1993	1781.3	28.5	125.0	252.8	100.9	398
35						
1987	1056.9					
1988	954.7	18.3	131.7	98.1	227.6	564
1989	943.5	19.3	120.0	130.1	249.9	565
1990	1055.5	20.5	119.3	129.4	250.1	650.1
1991	843.0	21.0	118.6	126.9	120.6	589.5
1992	807.4	21.1	117.9	125.0	107.4	625.2
1993	930.2	21.4	118.0	125.7	81.3	523
36						
1987	2902.2					
1988	2400.3	28.5	166.4	216.0	163	470.1
1989	2670.4	31.3	158.3	313.4	190.8	470.1
1990	2632.8	33.2	150.8	307.7	139.6	539.8
1991	2225.1	34.2	143.4	298.0	86.1	393.5
1992	2005.7	34.2	135.9	296.3	60.2	601
1993	2511.2	34.7	136.0	298.6	87.0	418
37						
1987	1705.1					
1988	1590.0	18.6	94.7	125.0	276.7	368.2
1989	1567.6	20.0	87.4	181.7	301.5	368.2
1990	1472.7	21.3	84.9	181.7	221.7	501.7
1991	1537.6	21.9	82.5	183.5	107.3	478.5
1992	1026.4	21.9	80.0	185.6	105.5	436.4
1993	1830.1	22.2	80.0	187.4	124.8	571
38						
1987	1320.9					
1988	1168.3	17.1	82.8	115.5	229.3	538
1989	1195.7	18.4	77.3	151.0	261.5	460.8
1990	1184.6	19.5	70.2	145.4	179.2	509.8
1991	1013.7	20.0	63.1	136.5	82.8	450.5
1992	714.7	20.1	56.0	143.4	74.7	447.2
1993	1237.8	20.3	56.0	152.0	79.3	579
39						
1987	549.2					
1988	525.3	8.4	32.9	59.4	545.7	541.4
1989	521.2	9.1	25.4	75.5	569.7	541.4
1990	492.0	9.7	22.9	74.6	428	785.7
1991	381.7	10.0	20.5	75.3	308.1	649.3
1992	262.4	10.0	18.0	76.3	507.3	541.3
1993	490.9	10.1	18.0	91.5	600.5	608

40						
1987	821.2					
1988	699.9	17.8	71.8	81.1	423	598
1989	776.3	19.7	63.3	107.2	343.6	660.6
1990	815.0	20.9	59.9	106.1	292.3	662.1
1991	661.1	21.5	56.4	103.6	529	448.2
1992	468.5	21.5	53.0	109.8	542.7	588.5
1993	722.0	21.8	53.0	109.5	481.0	635
41						
1987	897.9					
1988	826.9	12.2	51.5	86.0	427.2	534
1989	903.7	13.4	38.1	104.0	637.1	422
1990	967.0	14.2	37.7	106.0	448.2	534
1991	743.8	14.6	37.4	105.3	356.9	518.9
1992	548.0	14.7	37.0	99.1	181.7	456
1993	1043.1	14.9	37.0	124.6	504.0	660
42						
1987	1786.9					
1988	1612.6	20.5	146.5	157.0	204.3	482.4
1989	1731.7	21.7	137.8	196.7	261.7	482.4
1990	1793.9	22.9	135.8	188.5	242.9	580.3
1991	1378.8	23.6	133.9	186.7	54.6	454.7
1992	1383.0	23.6	131.9	186.4	115.3	541.3
1993	1601.1	24.0	132.0	188.0	217.0	453
43						
1987	1031.8					
1988	951.4	16.9	142.5	96.1	272.1	660.3
1989	873.2	17.5	129.9	128.8	365.5	660.3
1990	1067.6	18.6	133.6	125.2	460.9	685.1
1991	841.6	19.1	137.2	122.3	229.4	626.4
1992	866.8	19.2	140.9	120.6	384.8	736.5
1993	948.3	19.4	141.0	120.4	277.0	553
44						
1987	1491.5					
1988	1370.0	19.7	74.3	126.9	390.8	504
1989	1298.5	20.9	63.8	146.8	447.8	310.4
1990	1639.2	22.2	59.2	148.3	397.8	514.4
1991	1110.1	22.8	54.6	144.3	333	438.9
1992	1068.3	22.8	50.0	145.3	254	417.6
1993	1439.5	23.1	50.0	150.9	280.6	614
45						
1987	594.7					
1988	588.2	10.1	43.6	65.1	362.7	462.6
1989	535.8	11.0	35.5	75.4	434.2	462.6
1990	565.1	11.8	32	75.0	352.1	369.5
1991	540.9	12.1	28.5	77.4	203.6	523.4
1992	481.3	12.1	25.0	76.3	180.5	470
1993	681.3	12.3	25.0	79.5	196.9	457

46						
1987	1777.3					
1988	1781.2	17.2	77.4	145.1	403.1	504
1989	1522.2	18.6	69.4	172.1	518.3	310.4
1990	1843.6	19.8	71.9	169.3	397.9	514.4
1991	1464.6	20.3	74.5	165.8	285.6	438.9
1992	1210.9	20.4	77.0	165.9	217.1	417.6
1993	1935.7	20.6	77.0	168.5	225.6	614
47						
1987	1338.4					
1988	1226.4	17.6	70.7	115.8	404.1	525
1989	1259.5	18.8	58.4	136.3	494.4	443.9
1990	1284.2	19.9	54.3	138.4	451.4	431.8
1991	1207.2	20.4	50.1	139.3	384.7	460.8
1992	911.0	20.5	46.0	139.1	230	461.3
1993	1550.2	20.8	46.0	148.8	197.7	558
48						
1987	1827.2					
1988	2162.4	28.9	148	225.5	320.4	537
1989	2858.2	30.5	141.1	257.0	303.4	518.4
1990	2734.6	32.4	134	266.0	246.4	529
1991	2026.8	33.3	127	267.0	45.2	489.7
1992	2342.9	33.4	119.9	265.9	66.7	658.3
1993	2562.9	33.9	120.0	276.4	163.7	441
49						
1987	526.1					
1988	527.3	10.3	54.9	69.6	373.9	560
1989	488.8	11.3	45.7	84.3	387.5	462.4
1990	562.5	12.1	40.8	86.8	324.1	497.2
1991	473.2	12.4	35.9	86.5	134.2	396.4
1992	294.1	12.4	31.0	77.5	316.9	410
1993	610.5	12.6	31.0	81.5	265.1	764

State sector data, by voivodship (county)[562]

	$Output_t$	Cap_{t-1}	Lab[563]	Land	Inputs (kgs. per hectare)
1					
1987	75.2				
1988	60.7	2.0	8.9	10.2	360.8
1989	68.8	1.9	7.7	10.2	409.2
1990	47.7	1.9	6.6	10.4	386.9
1991	40.9	1.9	5.4	6.7	321.4
1992	38.0	1.8	4.4	7.0	165.4
1993	40.3	1.6	3.2	7.1	151.7
2					
1987	68.6				
1988	50.6	1.7	2.5	13.9	396.1
1989	73.8	1.6	2.5	13.2	418.4
1990	41.3	1.6	2.5	14.2	346.8
1991	39.8	1.6	2.5	10.3	261
1992	28.2	1.5	1.8	8.7	130.5
1993	18.1	1.3	1.1	5.3	155.2
3					
1987	70.5				
1988	59.8	2.5	4.3	24.5	404.2
1989	82.9	2.3	4.2	25.0	383.9
1990	49.8	2.2	4.0	27.1	341
1991	36.1	2.3	3.9	12.8	261.7
1992	22.2	2.2	3.0	9.2	118.9
1993	11.9	1.9	2.7	4.4	42.9
4					
1987	34.8				
1988	31.0	1.9	5.1	5.9	610.8
1989	32.3	1.7	4.0	6.1	635
1990	11.1	1.7	3.0	6.5	565.5
1991	7.9	1.7	2.1	1.9	350.8
1992	7.5	1.6	2.0	1.9	324.7
1993	10.0	1.4	1.8	2.0	444.2
5					
1987	603.1				
1988	534.8	7.8	19.9	93.0	496.8
1989	541.3	7.6	18.5	92.6	574.5
1990	541.8	7.3	17.0	94.6	582.1
1991	352.9	7.5	15.8	77.3	349.2
1992	269.5	7.2	11.9	71.4	218.4
1993	338.0	6.2	9.0	67.7	190.9

[562] The regional differentiation mirrors the private sector.

[563] Data were extrapolated for years 1990-1993 (see 5.5.4).

6					
1987	59.0				
1988	49.3	1.6	3.0	14.0	362
1989	71.4	1.4	2.9	13.3	292.9
1990	43.9	1.4	2.8	14.1	266.9
1991	36.8	1.4	2.8	9.9	203.8
1992	27.0	1.4	1.8	7.5	112.8
1993	21.0	1.2	1.3	5.1	111.2
7					
1987	160.2				
1988	132.1	2.9	5.1	23.5	472.9
1989	149.8	2.8	5.2	23.8	614.2
1990	111.9	2.7	5.2	24.0	483.1
1991	73.5	2.8	5.3	19.0	426.4
1992	50.2	2.7	3.7	17.8	136
1993	38.8	2.3	2.2	12.6	126.5
8					
1987	94.8				
1988	88.4	3.1	9.4	20.6	460.4
1989	94.8	2.9	7.3	21.4	514.3
1990	54.2	2.8	5.3	21.8	446.2
1991	46.4	2.8	3.2	9.7	390.2
1992	27.2	2.7	2.3	9.6	245.4
1993	32.9	2.4	1.4	8.8	170.4
9					
1987	447				
1988	333.3	6.0	18.3	89.0	459.5
1989	496.8	5.7	16.8	89.1	518.3
1990	504.8	5.5	15.3	93.6	553.2
1991	356.1	5.7	13.7	92.2	376.9
1992	294.5	5.4	9.9	80.3	199.4
1993	292.7	4.7	6.5	78.4	202.6
10					
1987	305.5				
1988	206.8	5.0	14.7	49.7	504.8
1989	279.8	4.8	13.0	49.5	632.5
1990	227.4	4.6	11.6	51.8	505.1
1991	171.1	4.7	10.0	41.0	403.1
1992	135.4	4.5	6.8	35.1	163.9
1993	132.3	3.9	4.0	33.1	224.3
11					
1987	496.2				
1988	431.6	5.5	18.4	86.9	579.1
1989	508.0	5.4	17.2	88.8	683.8
1990	449.3	5.2	16.0	92.2	620.9
1991	380.8	5.3	14.8	78.5	490.6
1992	209.3	5.1	11.3	68.8	251.7
1993	205.1	4.4	8.0	56.4	309.3

12					
1987	112.7				
1988	88.5	2.3	6.5	28.7	534.2
1989	109.6	2.2	5.5	27.4	618.2
1990	104.0	2.1	4.7	29.1	507.2
1991	93.8	2.1	3.8	23.7	341.3
1992	57.7	2.0	2.3	20.6	204.9
1993	61.9	1.8	0.8	19.0	220.2
13					
1987	252.3				
1988	190.3	4.3	8.9	32.7	517.9
1989	244.5	4.1	8.0	32.7	573.8
1990	139.7	3.9	7.1	33.6	547.8
1991	128.3	4.0	6.2	21.4	507
1992	78.0	3.8	4.6	20.4	257
1993	107.5	3.4	3.0	18.8	246.9
14					
1987	219.4				
1988	217.5	4.0	12.7	35.4	493
1989	226.5	3.8	10.8	36.1	620.5
1990	151.5	3.7	9.0	37.3	645
1991	126.4	3.8	7.1	20.9	454.8
1992	84.5	3.6	5.4	20.8	251
1993	51.4	3.1	4.0	13.2	337.0
15					
1987	50.8				
1988	44.3	2.6	6.7	15.7	336.4
1989	54.8	2.4	5.7	16.0	374.1
1990	25.2	2.3	4.6	16.8	301.2
1991	25.7	2.3	3.8	6.5	182.8
1992	17.1	2.2	2.2	5.9	83.6
1993	16.0	1.9	0.8	4.6	114.0
16					
1987	89.8				
1988	84.6	3.0	3.7	16.6	436.3
1989	143.5	2.6	3.7	16.8	491.2
1990	70.9	2.5	3.7	17.3	437.5
1991	63.2	2.6	3.8	11.4	453.4
1992	36.7	2.5	2.7	10.9	243.1
1993	35.1	2.2	1.9	7.7	159.6
17					
1987	665.1				
1988	529.9	6.6	23.4	106.1	745.5
1989	867.8	6.4	20.9	104.5	769.2
1990	518.9	6.2	18.0	104.9	711.1
1991	340.0	6.4	15.9	92.6	503.3
1992	151.3	6.1	11.3	56.7	128.6
1993	164.9	5.3	7.5	53.0	111.4

18					
1987	32				
1988	26.9	1.5	4.5	6.1	471.3
1989	25.2	1.4	4.3	6.1	564.4
1990	20.3	1.3	4.2	6.2	357
1991	24.0	1.4	4.0	5.7	281.1
1992	18.6	1.3	3.2	4.7	270
1993	19.5	1.1	2.5	4.2	216.0
19					
1987	23.3				
1988	18.3	1.5	4.1	7.0	269.4
1989	16.4	1.3	4.0	6.4	254.5
1990	16.5	1.3	3.9	6.9	191.4
1991	11.5	1.3	3.8	5.1	59
1992	5.8	1.2	2.8	2.4	35.8
1993	6.4	1.1	1.9	2.3	13.0
20					
1987	375.6				
1988	335.2	3.8	11.2	58.2	708.4
1989	366.8	3.7	10.5	60.0	734.9
1990	327.5	3.6	9.2	61.3	770.5
1991	296.5	3.7	8.9	53.8	594.7
1992	219.5	3.5	6.8	51.0	191.6
1993	259.0	3.1	5.3	54.8	276.0
21					
1987	410				
1988	321.9	4.8	13.4	49.7	490.5
1989	427.8	4.7	12.8	50.0	593.9
1990	349.5	4.5	12.0	50.8	595.7
1991	299.8	4.6	11.6	39.6	459.3
1992	200.3	4.4	10.0	37.6	323.8
1993	277.3	3.8	9.1	32.3	256.0
22					
1987	37.8				
1988	30.3	2.4	3.9	7.0	347.9
1989	40.2	2.3	4.0	6.7	442
1990	15.8	2.3	4.1	6.9	365.3
1991	18.1	2.3	4.3	3.0	243.4
1992	11.0	2.2	3.5	2.4	144.8
1993	10.9	1.9	2.5	2.3	39.4
23					
1987	23				
1988	16.2	1.4	1.4	4.1	311.9
1989	23.8	1.3	1.4	4.4	338
1990	17.5	1.3	1.4	4.1	268.8
1991	19.5	1.3	1.9	3.0	146.3
1992	11.9	1.2	1.4	2.5	109.1
1993	10.5	1.1	1.2	2.0	193.2

24					
1987	26				
1988	22.0	0.9	2.5	5.2	476.1
1989	26.8	0.9	2.5	5.2	555
1990	13.4	0.9	2.4	5.1	461.2
1991	16.6	0.9	2.3	2.3	370.6
1992	7.8	0.8	1.7	2.5	167.9
1993	8.9	0.7	1.2	2.6	301.1
25					
1987	3.5				
1988	2.9	0.9	2.7	8.9	236.1
1989	2.9	0.8	2.5	0.9	209.5
1990	2.4	0.8	2.3	1.0	171.3
1991	1.7	0.8	1.9	0.7	44.6
1992	1.5	0.7	1.0	0.5	34
1993	1.7	0.7	1.2	0.4	38.0
26					
1987	660.4				
1988	438.1	8.1	27.2	132.0	476.2
1989	641.5	7.7	25.0	129.0	610.9
1990	601.6	7.4	24.3	131.0	526.4
1991	520.4	7.6	22.9	126.1	455.7
1992	367.1	7.2	16.5	114.8	187.7
1993	267.0	6.3	13.1	87.1	147.9
27					
1987	1006.7				
1988	922.7	8.7	24.9	124.0	638.6
1989	1003.6	8.4	23.0	128.0	745.8
1990	636.4	8.2	22.1	130.9	731.2
1991	619.8	8.4	19.1	87.5	595.2
1992	483.9	8.0	15.7	87.1	446.8
1993	566.0	7.0	13.1	75.8	489.9
28					
1987	15.8				
1988	10.9	1.3	1.5	3.7	516.7
1989	15.4	1.2	1.5	3.6	372.2
1990	7.8	1.2	1.5	3.3	294.3
1991	7.0	1.2	1.9	1.6	213.3
1992	5.1	1.2	1.3	1.2	131.7
1993	4.5	1.0	1.0	1.2	69.6
29					
1987	418.2				
1988	374.1	5.8	16.7	81.0	493
1989	471.9	5.4	15.4	85.0	680.2
1990	435.8	5.2	14.1	88.3	608.9
1991	308.2	5.4	12.8	74.9	413.6
1992	129.3	5.1	7.1	55.4	173.3
1993	83.7	4.5	4.5	24.3	154.8

30					
1987	39.7				
1988	32.7	2.0	2.6	10.2	417.1
1989	40.0	2.0	2.5	10.4	459.8
1990	17.2	1.9	2.5	10.2	413.2
1991	24.4	1.9	2.5	3.5	358.9
1992	10.9	1.8	2.0	3.5	389
1993	10.7	1.6	1.6	3.4	148.4
31					
1987	109.5				
1988	88.8	2.8	3.8	16.1	451.7
1989	100.2	2.6	3.8	16.7	515.5
1990	62.1	2.5	3.8	16.5	466.7
1991	54.2	2.6	3.8	10.1	344.9
1992	39.0	2.5	2.9	9.6	258.8
1993	23.7	2.2	2.0	4.4	251:3
32					
1987	936.2				
1988	787.6	9.9	32.1	117.2	580.5
1989	409.8	9.7	29.0	121.5	687.3
1990	657.1	9.3	26.0	120.6	651.1
1991	551.3	9.6	22.8	81.2	533.1
1992	363.4	9.1	18.3	79.3	356.5
1993	341.9	8.0	16.0	58.8	354.7
33					
1987	113.2				
1988	83.2	2.5	5.7	24.2	452.8
1989	110.9	2.4	5.0	23.4	630.8
1990	99.3	2.3	4.4	25.0	450.9
1991	66.7	2.4	3.9	21.7	240.1
1992	48.2	2.0	3.3	16.2	58.2
1993	54.1	2.3	2.8	17.7	105
34					
1987	29.3				
1988	26.8	2.0	2.5	6.2	383.8
1989	33.9	1.4	2.5	6.3	399
1990	21.9	1.4	2.5	6.7	316.6
1991	16.4	1.4	2.8	3.4	237.9
1992	11.7	1.4	1.8	3.2	132.1
1993	13.7	1.2	1.3	3.2	96.7
35					
1987	39				
1988	36.5	1.8	4.0	7.4	553.8
1989	40.3	1.7	4.0	7.4	619.8
1990	32.7	1.7	3.9	8.0	540.2
1991	24.5	1.7	3.8	5.2	255
1992	23.1	1.6	3.6	4.9	213.1
1993	16.4	1.4	3.3	3.9	86.5

36					
1987	27.8				
1988	20.3	2.2	2.4	4.8	377
1989	31.0	2.0	2.5	5.0	412.7
1990	16.5	1.9	2.5	5.6	295.8
1991	13.5	2.0	2.6	2.3	224.5
1992	9.6	1.9	2.0	2.7	122.8
1993	8.4	1.6	1.4	2.3	106.2
37					
1987	42				
1988	30.1	2.0	1.8	6.9	452.9
1989	35.5	1.8	2.0	6.6	463.2
1990	19.2	1.8	2.0	6.8	360.5
1991	24.7	1.8	2.4	3.6	312.8
1992	12.3	1.7	2.0	3.4	180.8
1993	14.5	1.5	1.8	2.8	192.5
38					
1987	56				
1988	36.6	1.9	3.9	9.8	419
1989	53.6	1.8	3.0	9.9	502.4
1990	28.9	1.7	2.8	9.9	422.9
1991	34.5	1.8	2.8	5.5	247
1992	18.6	1.7	2.1	5.0	184.3
1993	18.7	1.5	1.5	3.2	180.0
39					
1987	468.2				
1988	375.7	5.3	16.8	82.0	576.9
1989	483.2	5.0	15.3	82.1	745.6
1990	381.4	4.8	13.5	83.2	595.7
1991	244.7	5.0	12.2	78.6	421.6
1992	90.2	4.7	7.0	42.5	137.4
1993	104.4	4.1	3.1	37.4	90.3
40					
1987	264.8				
1988	185.6	4.9	14.2	64.8	410.5
1989	268.5	4.8	13.0	61.4	382.8
1990	238.1	4.6	12.0	61.0	295.8
1991	203.6	4.7	11.2	58.0	218.4
1992	114.0	4.5	6.5	43.3	132.5
1993	42.9	3.9	4.3	17.6	62.1
41					
1987	1059.7				
1988	897.9	9.5	31.8	156.8	506.5
1989	1150.4	9.1	28.0	158.3	626.6
1990	968.0	8.8	25.9	164.7	567.9
1991	738.6	9.1	23.4	139.3	407.7
1992	458.2	8.6	18.1	120.1	168.4
1993	432.5	7.5	16.0	97.6	214.8

42					
1987	30.4				
1988	24.8	1.9	3.3	6.2	286.3
1989	32.2	1.8	3.3	6.2	272.6
1990	25.1	1.7	3.5	6.6	274.1
1991	23.0	1.8	5.3	4.6	164.8
1992	14.3	1.7	1.3	3.3	102.7
1993	12.0	1.5	1.0	3.2	81.5
43					
1987	23.6				
1988	23.8	1.5	4.8	4.7	422.2
1989	27.9	1.3	4.1	4.8	594.5
1990	20.5	1.3	3.5	5.1	618.8
1991	19.2	1.3	3.6	3.0	321.3
1992	16.2	1.3	2.3	2.9	198.8
1993	10.4	1.1	1.4	2.0	160.3
44					
1987	264.2				
1988	227.1	4.0	10.6	38.7	566.2
1989	272.9	3.9	9.4	38.0	715.1
1990	253.3	3.7	8.1	39.8	587.7
1991	213.5	3.8	7.4	34.1	421.4
1992	176.2	3.6	5.6	33.8	306.9
1993	153.6	3.2	3.9	31.8	315.2
45					
1987	311.1				
1988	264.5	3.7	10.8	47.8	491
1989	273.8	3.6	9.8	48.7	596.3
1990	209.1	3.5	7.8	49.4	620.6
1991	205.5	3.6	6.7	38.7	556.8
1992	162.3	3.4	4.7	38.2	316.6
1993	182.7	3.0	2.5	38.0	313.4
46					
1987	88.4				
1988	73.0	2.5	3.9	12.8	568.4
1989	86.5	2.3	3.8	12.8	540.5
1990	64.6	2.2	3.8	12.9	437.6
1991	61.2	2.3	3.4	8.7	323
1992	40.6	2.2	2.5	7.3	283.3
1993	43.9	1.9	1.8	5.9	222.6
47					
1987	632.7				
1988	494.8	6.3	19.1	85.8	548.2
1989	610.4	6.0	18.5	88.2	597.5
1990	513.2	5.8	18.2	91.9	585.8
1991	508.5	6.0	18.0	84.1	435.2
1992	356.6	5.7	14.3	77.3	278.1
1993	415.3	4.9	11.0	75.5	284.4

48					
1987	144.8				
1988	114.5	2.7	4.7	24.6	327.9
1989	177.4	2.5	4.7	24.0	356.7
1990	127.3	2.4	4.7	26.3	268.7
1991	105.6	2.5	4.7	20.4	213.4
1992	107.6	2.3	3.7	21.1	99.6
1993	101.1	2.0	2.8	17.1	141.8
49					
1987	333.2				
1988	286.8	5.5	15.1	72.5	622.8
1989	336.5	5.1	14.2	74.1	689.9
1990	329.9	4.9	13.4	78.6	648.3
1991	264.2	5.0	12.5	64.8	482.3
1992	125.7	4.8	7.7	51.9	234.6
1993	139.0	4.2	2.8	40.8	128.8

Appendix II: List of Interviewees

Phase I (May-July 1993)

Director Anuszewski	Forecasting, Ministry of Agriculture, Warsaw
Professor Bedlechowicz	Department of Agriculture and Food Management, Regional Office, Lodz
Professor Borek	Agricultural Sector Adjustment Programme (ASAP), Ministry of Agriculture, Warsaw
Director Choynowoki	Agricultural Property Agency of State Treasury, Lodz
Mr Lipinski	European Fund for Development of Polish Agriculture, Ministry of Agriculture, Warsaw
Mr Malinowski	Director of Environmental Protection, Regional Office, Lodz
Ms Magdalena Nawicka	Polish American Research Unit, Ministry of agriculture, Warsaw
Madame Nowak	Local Agricultural Advisor in Wagry, Poland
Mr Terewszniski	Department of Agriculture, Regional Office, Lodz
Professor Wos	Institute of Agricultural Economics, Foundation for Development of Polish Agriculture, Warsaw
Mr Wosniak	BRATOSZEWICACH, Agricultural Extension Service Centre, Lodz

Phase II (March 1994)

Mr Simon Banks	External Secondment to DG I, ex-British Embassy in Warsaw
Mr Bialobrzycki	Commission, DG I, PHARE, Agriculture, Brussels
Mr Pascual Bremon	Commission DG I,EC Relations with Poland, Brussels
Mr Simon Butt	UK Representative EC relations with Central and Eastern Europe, Brussels
Mr Paul Howell	Member of European Parliament, Conservative, Brussels
Ms Pampoloni	Commission, DG I, PHARE, Agriculture, Brussels
Ms Fiona Reed	Commission DG VI, Agriculture, Brussels
Mr Wierczorek	Counsellor at the Polish Mission to the EC, Brussels

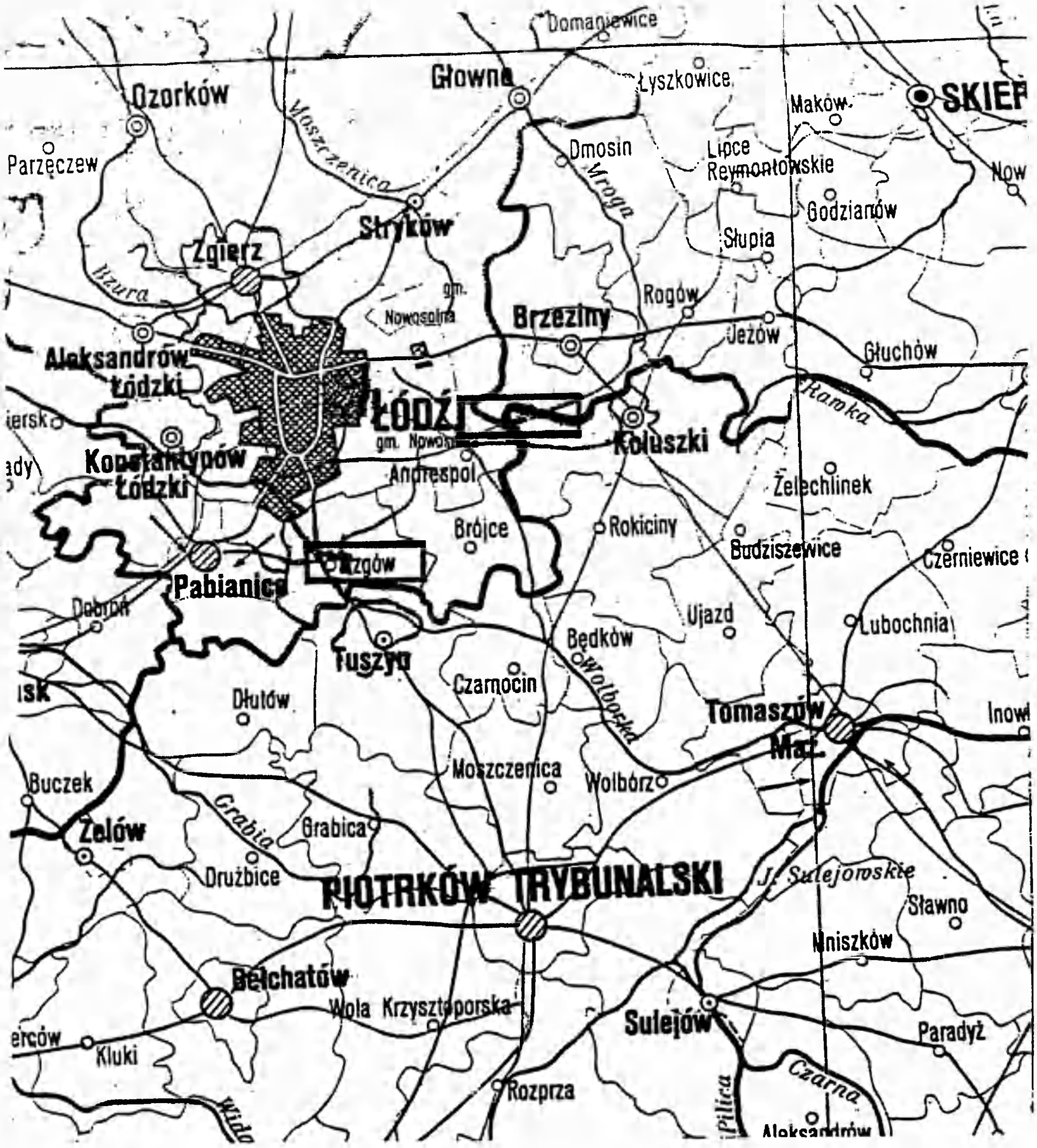
Phase III (October-December 1994)

Dr Derek Baker	Agricultural Policy Analysis Unit, Foundation for Assistance Programme for Agriculture (FAPA), Warsaw
Dr Borek	ASAP, FAPA, Ministry of Agriculture, Warsaw
Mr David Hughes	Agricultural Development Fund, UK Government, ADF Field Manager, ASAP, Ministry of Agriculture, Warsaw

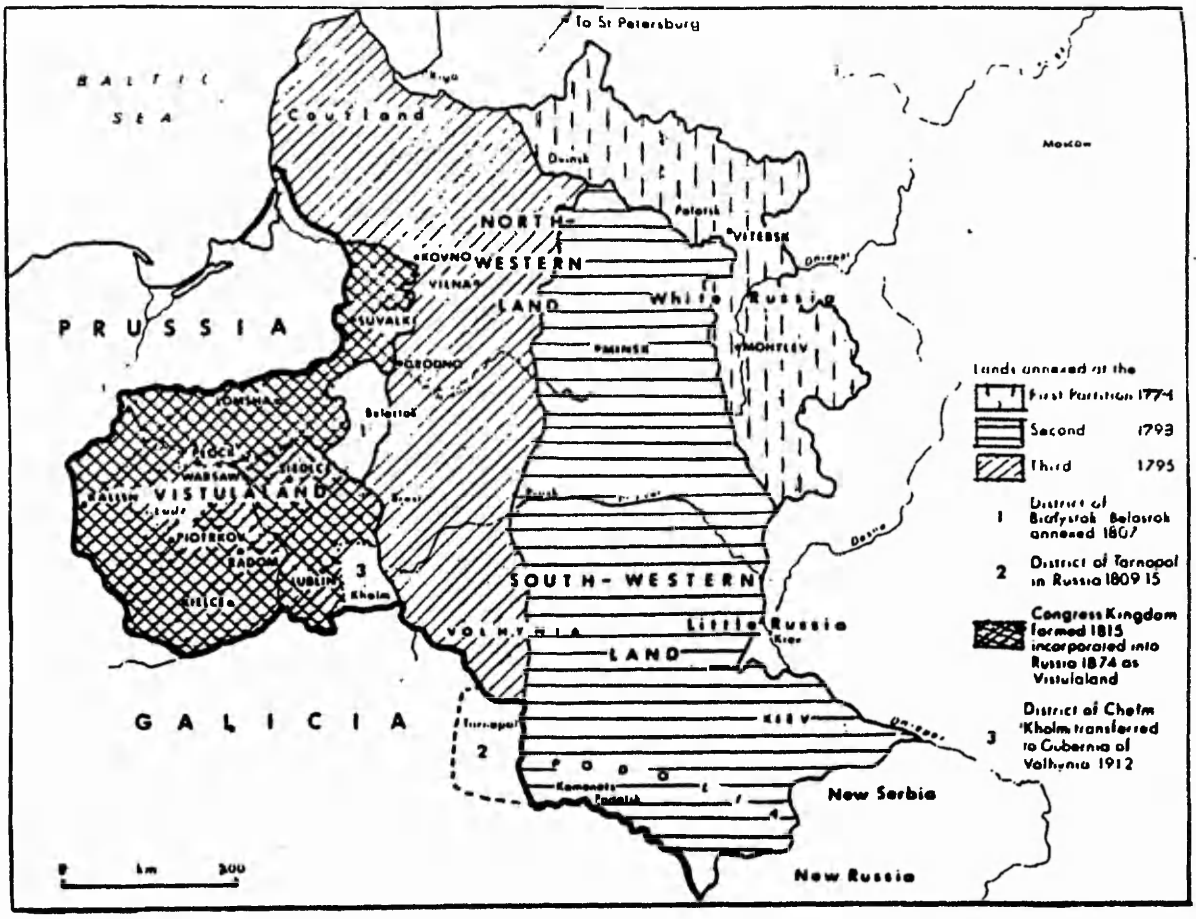
Miss Yvonne Kent	PHARE in Poland, Warsaw
Dr Kisiel	Institute of Agriculture and Food Economics, Warsaw
Director Kwiecinski	Director of Agricultural Policy Analysis Unit, FAPA, Ministry of Agriculture, Warsaw
Dr Rowinski	Specialist in EU relations (Advisor to the Polish government, Council of Ministers), Institute of Agricultural and Food Economics, Warsaw
Dr Anita Santorum	Agricultural Sector Adjustment Programme (ASAP), FAPA, Ministry of Agriculture, Warsaw
Mr Andrew Smith	Commercial Secondment, The British Embassy in Warsaw
Professor Anna Szemberg	Institute of Agriculture and Food Economics, Warsaw

* The positions held above were those held during Phase I, II and III of the interviews, May-July 1993, March 1994 and October-December 1994 respectively.

Appendix III

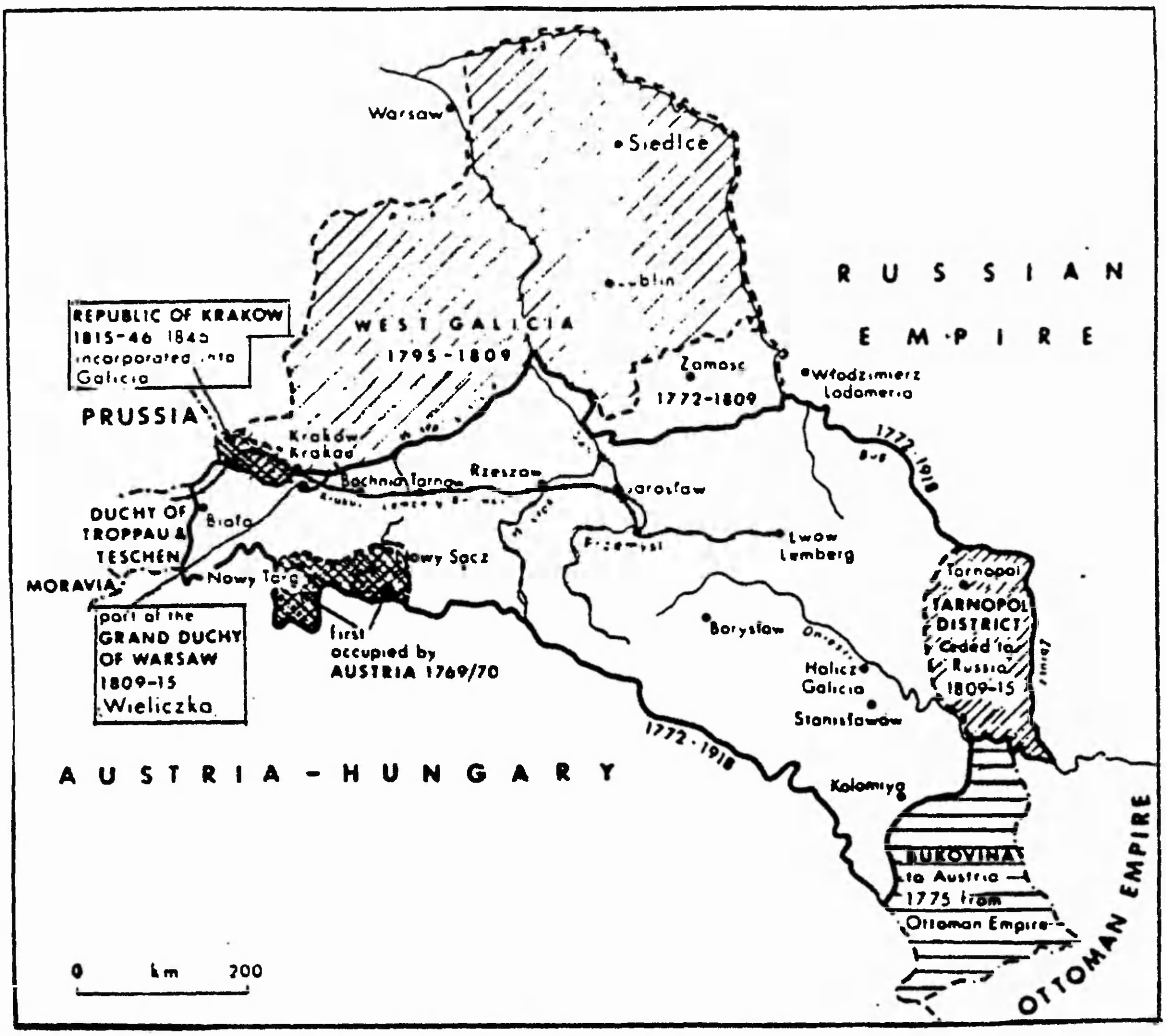


Map III.I: Location of Wagry (bordering Lodz, Piotrkow and Skierniewice voivodships (counties); and Rzgow



Map III.2: The Russian Partition (1773-1915)

<u>**Map III.3: The Prussian Partition (1773-1918)**</u>



Map III.4: The Astro-Hungary Partition (1773-1918)

Map III.5: Division of Polish arable land, by region (Northwest, Northeast, Southwest and Southeast), 1988-1993

Appendix IV (refer to Chapters 2, 3 and 6)

IV.1 Introduction

Appendix IV contains additional information on the theory of production and the associated laws or principles of economics.

IV.2. Technological process

Advancements in technical knowledge leads to shifts in the production function so that more output can be produced with a given set of inputs.

IV.3 Returns To Scale

To increase the level of production, it is necessary to increase each of the inputs without changing their proportions; the increases must be equiproportionate.

i) *Increasing Returns To Scale* is when output is doubled but the change in inputs is less than doubled.

ii) *Constant Returns To Scale* is when twice the amounts of inputs are used to double the level of output.

iii) *Decreasing Returns To Scale* is when more than double the quantities of inputs are used to double output.

IV.4 Factor Substitution

This is when one factor is replaced by another. For example, a labour intensive choice may be replaced with a capital intensive selection.

IV.5 The law of Diminishing Returns

If more and more of a variable factor is applied to a fixed quantity of other factors, eventually the resulting increases in output must diminish. For example, in the case of agriculture in which fixed input is land and the variable input is labour, at first only the most productive land is used and labour is highly productive. Eventually as output expands, worse and worse lands are pressed into service so that productivity of the last labourers is less than that of the first (Heathfield and Wibe, 1987).

IV.6 Economies of Scope

Economies of scope occur when there are factors which make it cheaper to produce a range of related products than to produce any of the individual products on their own.

IV.7 Economies of Scale

Economies of scale result when factors cause the average cost of producing a commodity falls as output of the commodity rises. For example, a firm which doubles its output, without doubling its costs. The factors are increased in the same proportion to obtain greater outputs and larger plant sizes.

IV.8 Economies of Size

Economies of size are brought about when all the factors are *not* increased in the same proportion, and are usually associated with larger plant sizes. Two important economies of size are (1) increasing possibilities of division of labour and specialisation of labour, and (2) increasing possibilities of using advanced technological developments and/or larger machines (Eckert and Leftwich, 1988).

Appendix V

Table V.1: Regional Trends in Polish private arable production. 1988-1993

P	1987	1988	1989	1990	1991	1992	1993	Change (%) (1988-1993)
Output (1000 tonnes)								
NW	17537.3	16722.6	15603.8	18281.7	14586.5	10465.8	18409.0	10.1
NE	8233.5	7360.0	7648.1	7846.8	6659.8	5758.8	7787.4	5.8
SE	20381.8	17743.3	20242.9	20868.2	16579.0	15952.3	19287.4	8.7
SW	18093.8	15517.6	14632.9	15942.8	14534.2	11522.8	17250.7	11.2
Total	64,246.4	57,343.5	58,127.7	62,939.5	52,359.5	43,699.7	62,734.5	9.4
Output (per hectare)								
NW	/	10.39	7.89	9.31	7.54	5.49	8.98	-13.6
NE	/	9.81	7.64	7.96	6.90	6.00	7.87	-19.8
SE	/	9.60	8.36	8.72	7.05	6.83	8.14	-15.2
SW	/	10.28	7.50	8.28	7.60	6.08	8.84	-14.0
Capital (1000 pieces)								
NW	243.7	261.8	277.4	286.3	286.9	290.6	295.2	12.8
NE	136.7	133.8	141.9	145.7	146.2	148.1	150.3	12.3
SE	259.3	279.3	296.2	304.4	305.1	309.3	314.0	12.4
SW	240.3	257.0	272.5	280.0	280.6	284.6	288.9	12.4
Total	880.00	931.90	988.00	1,016.40	1,018.80	1,032.60	1,048.40	12.5
Output (per tractor)								
NW	72.0	63.88	56.25	63.86	50.84	36.01	62.36	-2.4
NE	60.23	55.01	53.90	53.86	45.55	38.88	51.81	-5.8
SE	78.60	63.53	68.34	68.56	54.34	51.58	61.42	-3.3
SW	75.30	60.38	53.70	56.94	51.80	40.50	59.71	-1.1
Total	73.01	61.53	58.83	61.92	51.39	42.32	59.84	-2.7
Cultivated Land (1000 hectares)								
NW	/	1609.4	1977.8	1963.3	1933.6	1905.5	2050.4	27.4
NE	/	750.1	1000.5	985.5	964.9	959.4	988.9	31.8
SE	/	1847.5	2420.7	2392.7	2353.0	2336.1	2368.9	28.2
SW	/	1510.0	1951.4	1924.6	1912.8	1893.9	1951.4	29.2
Total	/	5,717.00	7,350.40	7,266.10	7,164.30	7,094.90	7,359.60	28.7

Table V.1 (contd.): Regional Trends in Polish private arable production. 1988-1993

P	1987	1988	1989	1990	1991	1992	1993	Change (%) (1988-1993)
Area of cultivated land (per worker)								
NW	/	1: 1.81	1: 2.45	1: 2.52	1: 2.57	1: 2.63	1: 2.83	56.4
NE	/	1: 1.25	1: 1.84	1: 1.90	1: 2.00	1: 2.05	1: 2.11	68.8
SE	/	1: 1.12	1: 1.47	1: 1.48	1: 1.49	1: 1.50	1: 1.52	35.8
SW	/	1: 1.35	1: 1.81	1: 1.94	1: 2.09	1: 2.26	1: 2.33	72.8
Labour (1000 persons)[a]								
NW	/	889.6	808.6	780.5	753.0	723.0	725.0	-18.5
NE	/	601.5	542.7	518.1	493.5	467.6	467.6	-22.3
SE	/	1650.9	1641.5	1613.1	1584.4	1556.1	1557.0	-5.7
SW	/	1114.7	1076.1	993.4	916.2	836.4	836.5	-25.0
Total	/	4,256.70	4,068.90	3,905.10	3,747.10	3,583.10	3,586.10	-15.8
Output (per worker)								
NW	/	18.80	19.30	23.42	19.37	14.44	25.39	35.1
NE	/	12.24	14.09	15.15	13.50	12.32	16.65	36.0
SE	/	10.75	12.33	12.94	10.46	10.25	12.39	15.3
SW	/	13.92	13.60	16.05	15.86	13.78	20.62	48.1
Total	/	13.47	14.29	16.12	13.97	12.20	17.50	29.9
Inputs[b] (1000 tonnes)								
NW	/	651.3	947.2	811.1	596.5	530.1	516.2	-20.7
NE	/	176.3	269.9	216.6	162.5	159.3	167.5	-5.0
SE	/	420.5	583.9	498.1	236.9	242.3	324.6	-22.8
SW	/	481.3	684.0	554.7	331.7	259.1	279.1	-42.0
Total		1,729.40	2,485.00	2,080.50	1,327.60	1,190.80	1,287.40	-25.6
Inputs (average kgs)/hectare								
NW	/	416.2	486.7	415.8	306.9	285.4	260.4	-37.4
NE	/	262.2	292.6	238.5	201.1	181.0	176.8	-32.6
SE	/	229.7	242.1	214.3	102.9	110.6	133.4	-41.9
SW	/	324.2	359.6	297.5	185.9	151.6	152.6	-52.9
Total	/	308.08	345.25	291.53	199.20	182.15	180.80	-41.20

Table V.1 (contd.): Regional Trends in Polish private arable production. 1988-1993

P	1987	1988	1989	1990	1991	1992	1993	Change (%) (1988-1993)
Average rainfall (mm)								
NW	/	495.42	410.52	571.74	521.40	453.26	638.80	28.9
NE	/	601.83	585.0	606.77	610.63	591.20	619.57	2.9
SE	/	552.96	564.31	603.15	527.75	617.64	496.15	-10.3
SW	/	525.99	473.04	525.54	510.24	497.21	547.00	4.0
Total	/	544.05	508.22	576.80	577.77	539.83	575.38	5.8
Capital/labour ratio								
NW	/	1: 3.40	1: 2.91	1: 2.73	1: 2.62	1: 2.49	1: 2.46	-27.6
NE	/	1: 4.50	1: 3.82	1: 3.56	1: 3.38	1: 3.16	1: 3.11	-30.9
SE	/	1: 5.91	1: 5.54	1: 5.30	1: 5.19	1: 5.03	1: 4.96	-16.1
SW	/	1: 4.34	1: 3.95	1: 3.55	1: 3.27	1: 2.94	1: 2.90	-33.2
Capital/land ratio								
NW	/	1: 6.15	1: 7.13	1: 6.86	1: 6.74	1: 6.56	1: 6.95	13.0
NE	/	1: 5.61	1: 7.05	1: 6.76	1: 6.60	1: 6.48	1: 6.58	17.3
SE	/	1: 6.61	1: 8.17	1: 7.86	1: 7.71	1: 5.03	1: 7.54	14.1
SW	/	1: 5.88	1: 7.16	1: 6.87	1: 6.82	1: 6.65	1: 6.75	14.8

[a]denotes labour intrapolated for years 1990-1991
[b]denotes inputs, in tonnes=(inputs per hectare (kgs) x cultivated land/1000 hectares)
NW=northwest; NE=northeast; SE=southeast; SW=southwest

[Source: GUS. var. issues]

Table V.2: Regional Trends in Polish (former) state arable production, 1988-1993

S	1987	1988	1989	1990	1991	1992	1993	Change (%) (1988-1993)
Output (1000 tonnes)								
NW	6837.1	5655.4	6720.7	5892.4	4473.9	2758.6	2851.9	-49.6
NE	1234.2	874.6	1200.1	1035.7	872.8	593.8	414.0	-52.7
SE	651.1	625.6	713.1	488.4	402.5	327.2	284.3	-54.6
SW	3128.7	2708.5	3019.7	2206.8	2111.4	1521.1	1677.1	-38.1
Total	11,851.1	9,864.1	11,653.6	9,623.3	7,860.6	5,200.7	5,227.3	-55.9
Output (per hectare)								
NW	/	5.21	6.13	5.23	4.78	3.58	4.43	-15.0
NE	/	3.58	5.03	4.31	4.04	3.14	3.19	-10.9
SE	/	4.33	5.34	3.41	4.12	3.93	4.19	-3.2
SW	/	5.65	6.17	4.38	5.83	4.44	5.41	-4.2
Total	/	5.05	5.95	4.78	4.88	3.75	4.54	-10.10
Capital (1000 pieces)								
NW	85.5	81.8	78.6	81.0	77.1	67.3	51.6	-36.9
NE	22.5	21.4	20.8	21.2	20.2	17.6	13.5	-36.9
SE	25.3	22.9	22.4	22.8	21.7	18.9	14.5	-36.7
SW	45.5	43.4	42.0	43.1	40.9	35.8	27.9	-35.7
Total	178.80	169.50	163.80	168.10	159.90	139.60	107.50	-36.6
Output (per tractor)								
NW	79.97	69.14	85.51	72.75	59.34	40.99	55.27	-20.1
NE	54.85	40.87	57.15	48.85	43.00	33.74	30.67	-25.0
SE	25.74	27.32	31.83	21.42	18.38	17.31	19.61	-28.2
SW	68.76	62.41	71.90	51.20	51.62	42.49	60.11	-3.7
Total	66.28	58.20	71.15	57.25	49.16	37.25	48.63	-16.64
Cultivated land (1000 hectares)								
NW	/	1084.7	1095.8	1126.9	935.6	771.5	644.0	-40.6
NE	/	244.2	238.5	240.3	216.3	188.9	129.6	-46.9
SE	/	144.6	133.6	143.2	96.1	83.2	67.9	-53.0
SW	/	479.3	489.7	503.5	361.9	342.5	310.1	-35.3
Total	/	1,952.8	1,957.6	2,013.9	1,609.9	1,386.1	1,151.6	-41.0

Table V.2 (contd.): Regional Trends in Polish (former) state arable production, 1988-1993

S	1987	1988	1989	1990	1991	1992	1993	Change (%) 1988-1993
Area of cultivated land (per worker)								
NW	/	1: 4.38	1: 4.86	1: 5.48	1: 5.02	1: 5.72	1: 6.63	51.4
NE	/	1: 3.85	1: 4.13	1: 4.45	1: 4.27	1: 5.28	1: 4.84	25.7
SE	/	1: 2.87	1: 2.80	1: 3.17	1: 2.10	1: 2.68	1: 2.98	3.8
SW	/	1: 4.10	1: 5.48	1: 5.14	1: 4.09	1: 5.01	1: 6.03	47.1
Labour (1000 persons)[a]								
NW	/	247.6	225.5	205.5	186.3	134.8	97.1	-60.8
NE	/	63.4	57.8	54.0	50.7	35.8	26.8	-57.7
SE	/	50.3	47.7	45.2	45.8	31.1	22.8	-54.7
SW	/	117.0	89.3	98.0	88.5	68.4	51.4	-56.1
Total	/	478.30	420.30	402.70	371.30	270.10	198.10	-58.6
Output (per worker)								
NW	/	22.8	29.8	28.7	24.0	14.4	29.4	28.9
NE	/	13.8	20.8	19.2	17.2	16.6	15.4	11.6
SE	/	12.4	14.9	10.8	8.8	10.5	12.5	0.8
SW	/	23.1	33.8	22.5	23.9	22.2	32.6	41.1
Total	/	20.62	27.73	23.90	21.17	19.25	26.39	27.97
Inputs[b] (1000 tonnes)								
NW	/	599.2	715.4	676.5	410.2	170.6	139.3	-76.8
NE	/	111.0	127.8	108.4	81.8	32.0	18.0	-83.8
SE	/	53.3	57.2	49.2	20.9	9.6	6.9	-87.1
SW	/	268.7	309.0	308.3	176.3	102.2	100.4	-62.6
Total	/	1,032.20	1,209.40	1,142.40	689.20	314.40	264.60	-74.4
Inputs (average kgs) per hectare								
NW	/	543.0	634.8	576.7	436.4	229.8	212.1	-60.9
NE	/	451.4	480.3	402.9	304.6	169.6	170.7	-62.2
SE	/	365.5	406.0	339.1	204.0	116.6	92.5	-74.7
SW	/	508.9	562.3	509.2	396.1	250.1	244.5	-52.0
Total	/	467.20	520.85	456.98	335.28	191.53	179.95	-62.45

Table V.2 (contd.): Regional Trends in Polish (former) state arable production, 1988-1993

S	1987	1988	1989	1990	1991	1992	1993	Change (%) 1988-1993
Capital/labour ratio								
NW	/	1: 3.02	1: 2.87	1: 2.54	1: 2.42	1: 2.00	1: 1.88	-37.7
NE	/	1: 2.96	1: 2.78	1: 2.55	1: 2.51	1: 2.03	1: 1.99	-32.8
SE	/	1: 2.20	1: 2.13	1: 1.98	1: 2.11	1: 1.65	1: 1.57	-28.6
SW	/	1: 2.70	1: 2.13	1: 2.27	1: 2.16	1: 1.91	1: 1.84	-31.9
Capital/land ratio								
NW	/	1: 13.3	1: 13.9	1: 13.9	1: 12.1	1: 11.5	1: 12.5	-6.0
NE	/	1: 11.4	1: 11.5	1: 11.3	1: 10.7	1: 10.7	1: 9.6	-15.8
SE	/	1: 6.3	1: 6.0	1: 6.3	1: 4.4	1: 4.4	1: 4.7	-25.4
SW	/	1: 11.0	1: 11.7	1: 11.7	1: 8.8	1: 9.6	1: 11.1	0.9

[a]denotes labour extrapolated for years 1990-1993
[b]denotes inputs, in tonnes=(inputs per hectare (kgs) x cultivated land/1000 hectares)
NW=northwest; NE=northeast; SE=southeast; SW=southwest

[Source: GUS, var. issues]

Appendix VI

Table VI.1: Management of APStock Land

Region	NW	NE	SE	SW	Total
Land taken over into APStock	1,716,715 (52.6)	905,278 (27.8)	175,961 (5.4)	462,686 (14.2)	3,260,640
Sold	39,661 (67.9)	6,446 (11.0)	7,151 (12.2)	5,126 (8.8)	384
Given away free of charge	5,434 (54.3)	3,838 (38.3)	538 (5.4)	203 (2.3)	10,013
APA Stock, land (31.12.93) of which:					
Total	1,671,844 (52.4)	894,994 (28.0)	168,272 (5.3)	457,357 (14.3)	3,192,243
Lease	523,304 (58.6)	242,122 (27.1)	41,718 (4.7)	86,311 (9.7)	893,455
Stewardship	999,491 (49.4)	599,577 (29.6)	82,088 (4.1)	342,716 (16.9)	2,023,872
Adminstration	75,388 (81.2)	9,025 (9.7)	8,383 (9.0)	0	92,796
Fallow	10,236 (15.3)	23,967 (35.7)	29,490 (44.0)	14,506 (21.6)	67,050
Land awaiting formal disposition	63,201 (54.9)	20,303 (17.6)	6,593 (5.7)	21,722 (18.9)	115,070

[Source: APA, 1994: Annex 20]

Table VI.2: Employment Changes relating to PPGR (state farm) Restructuring

Employees of the ppgr taken over into APstock	NW	NE	SE	SW	Total
Total, of which:	87,863 (51.4)	48,890 (28.6)	8,194 (4.8)	26,085 (15.3)	171,032
ST farms	47,406 (45.3)	35,880 (34.3)	5,140 (4.9)	16,326 (15.6)	104,752
New Owners	19,058 (69.3)	3,465 (12.6)	671 (2.4)	1,605 (5.8)	27,493
Dismissed	18,820 (56.8)	8,195 (24.7)	2,110 (6.4)	4,505 (13.6)	33,154
Pensions	2333 (41.4)	1,350 (24.0)	273 (4.8)	955 (17.0)	5,633

percentages in parentheses;
NW=Northwest; NE=Northeast; SE=Southeast; SW=Southwest

[Source: APA, 1994: Annex 28]

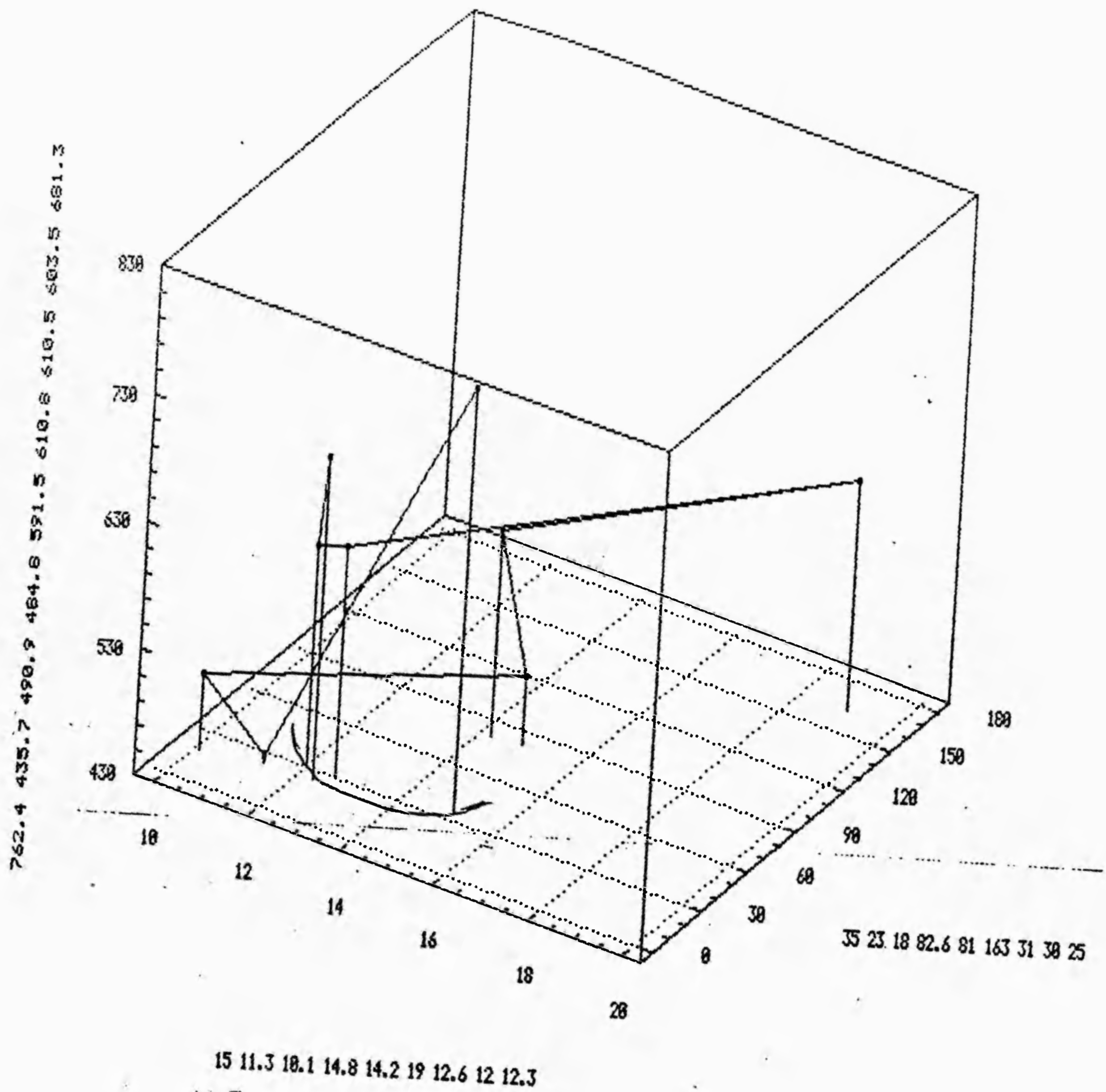
Appendix VII

VII.1 Graphical Application

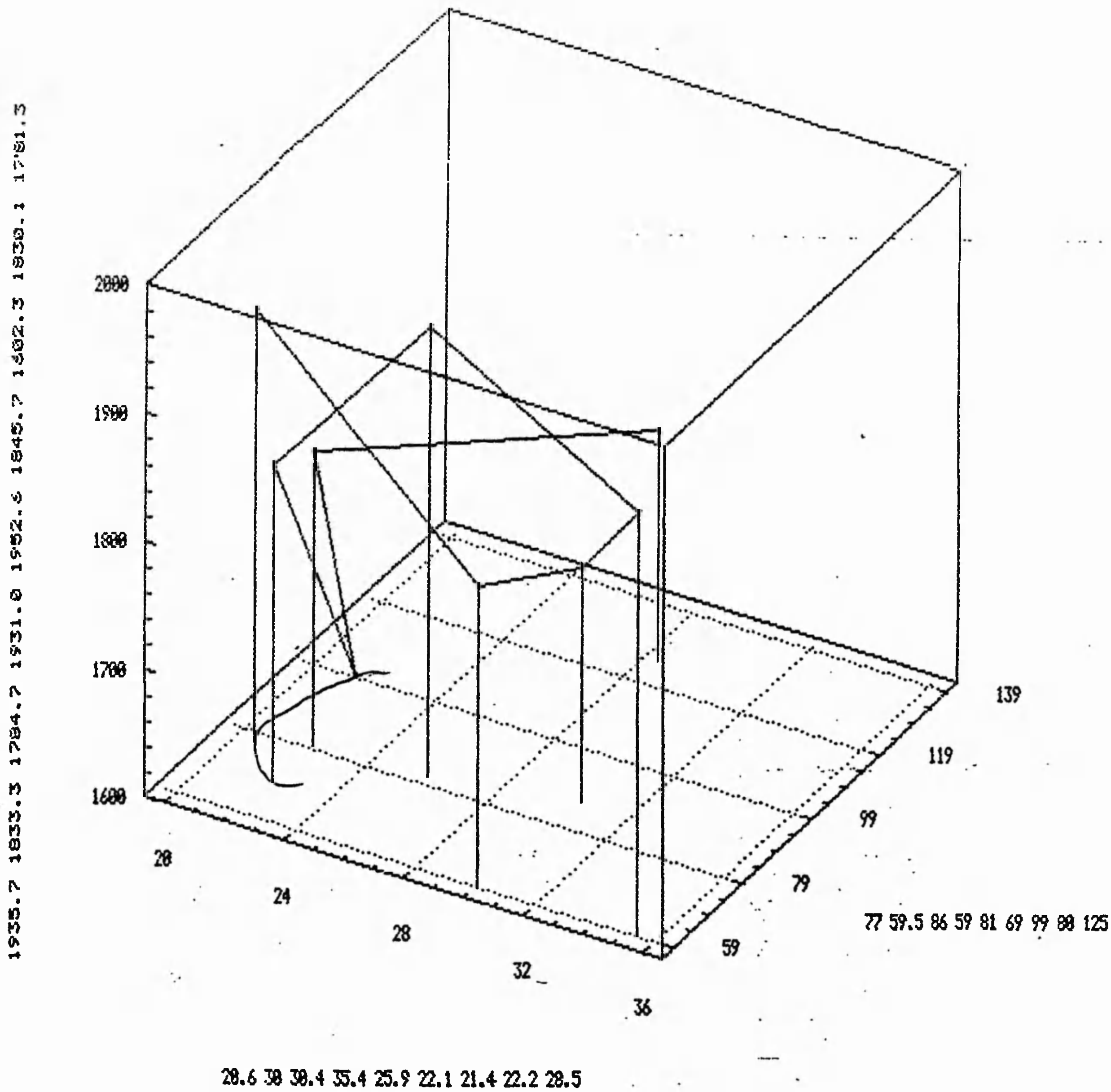
Alongside the algebraic proofs, an arbitrary test using raw data was devised to determine the gradients (positive or negative) of the isoquants for the national private and (former) socialised producers of Polish arable output, as presented in this thesis (1988-1993).[564] The analysis was limited to three 'conventional' explanatory variables[565], namely, output, capital and labour, and three (approximate) categories of aggregate arable output were selected from the secondary agricultural data gathered on all 49 Polish voivodships (counties). Three-dimensional graphs were used to illustrate the alternative combinations of arable output against its corresponding combination of 'conventional' inputs, namely 'capital' and 'labour' inventories. At the cross-section of the labour and capital planes, the isoquants appeared convex to the origin and negatively sloping (see below). In fact, the results were consistent for all three categories of arable production and in both the private and (former) state sectors.

[564]A test of convexity is particularly relevant to the present investigation of Polish agricultural production. This is primarily because of characteristics associated with economic transition. These include imperfect information and perhaps unreliable price signals. Consequently, factor usage may have been perverse and the allocation of resources uneconomical. For example, a higher cost factor (capital) may have been substituted for a lower cost factor (labour).

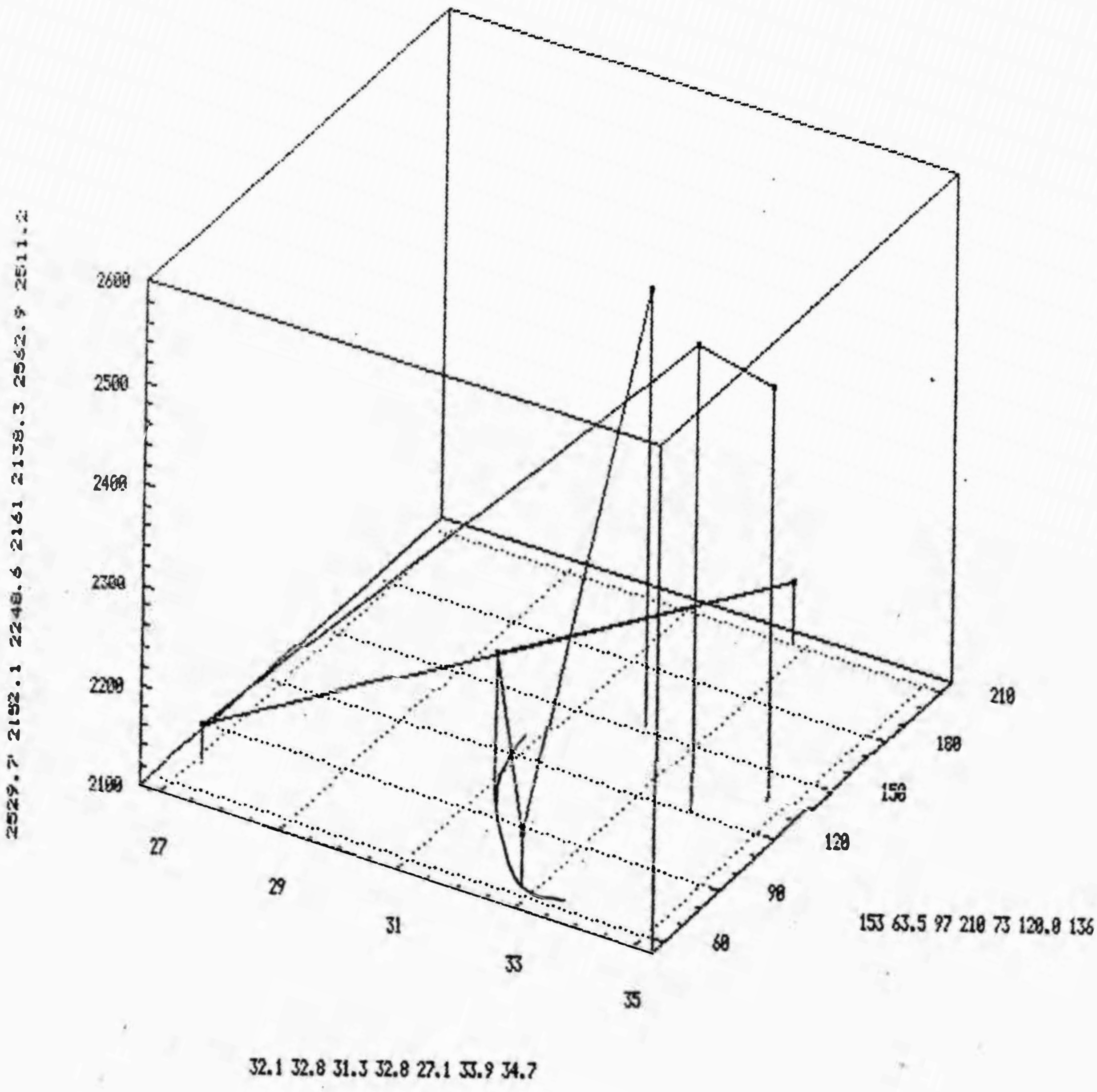
[565]It is acknowledged that this particular test may be elaborated to include some of the other exogenous variables, such as fertilisers or land, which are included within this Cobb Douglas model of arable production.



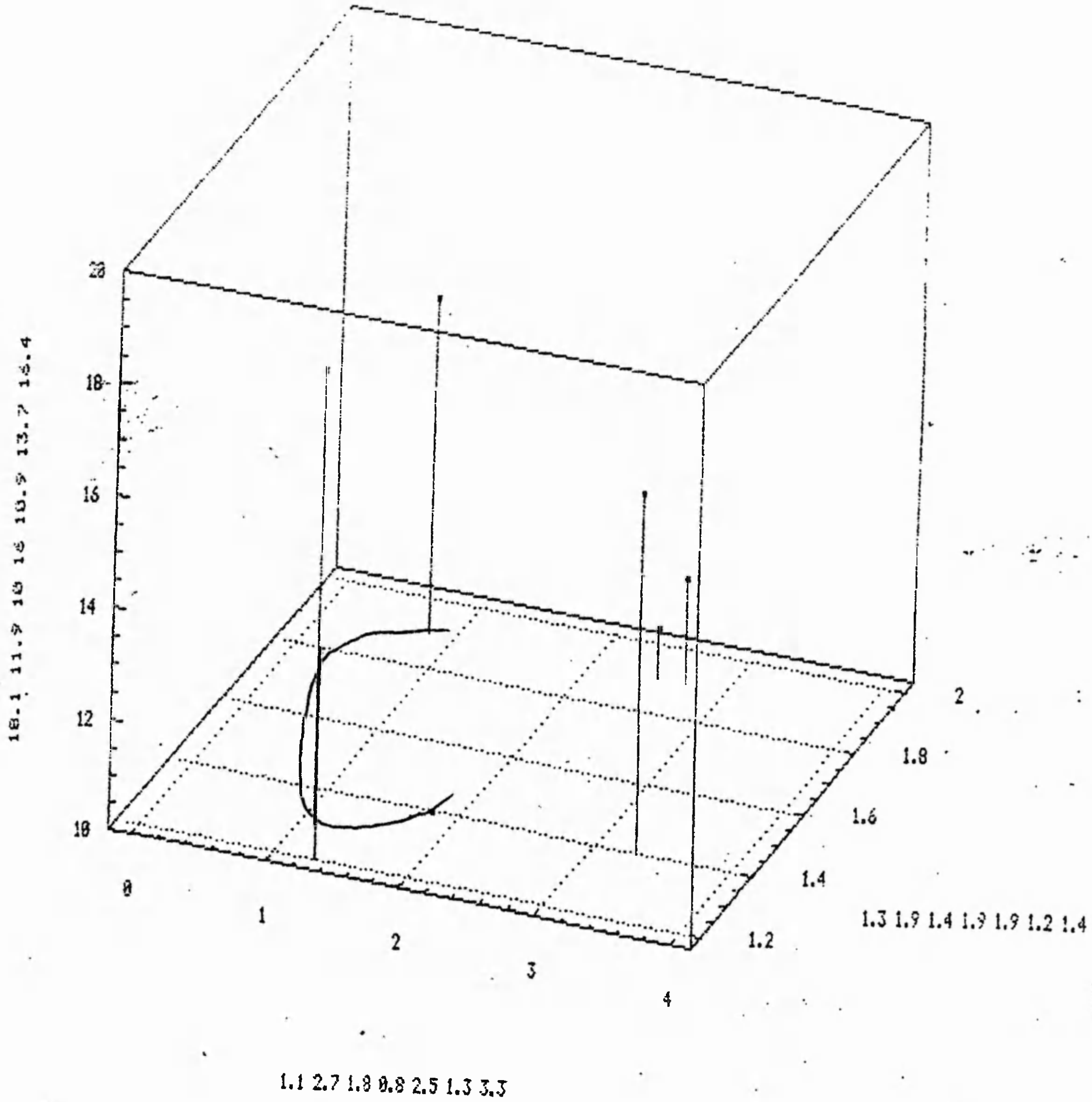
(i) 400-800 thousand private arable tonnes



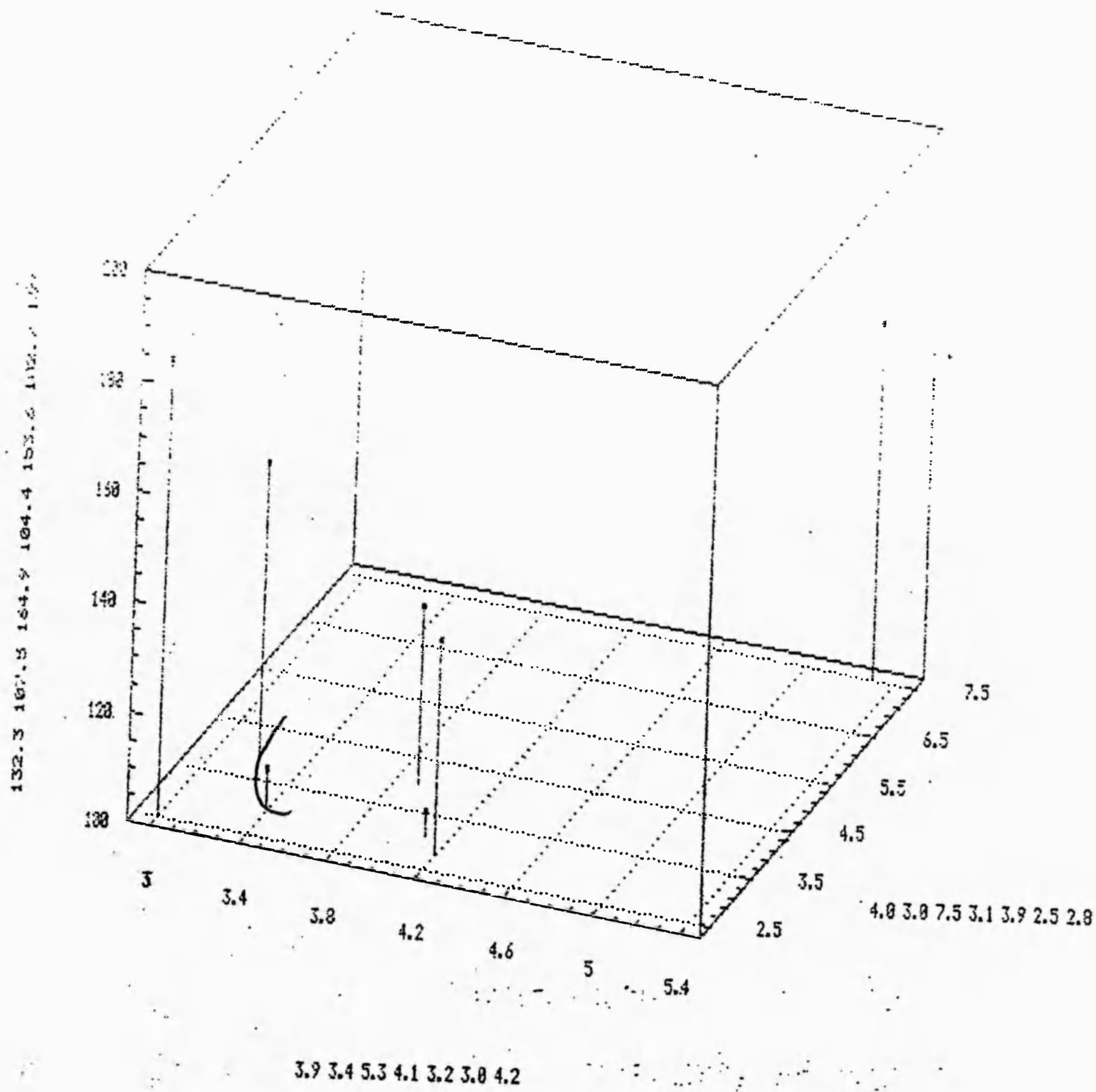
(ii) 1600-1900 thousand private arable tonnes



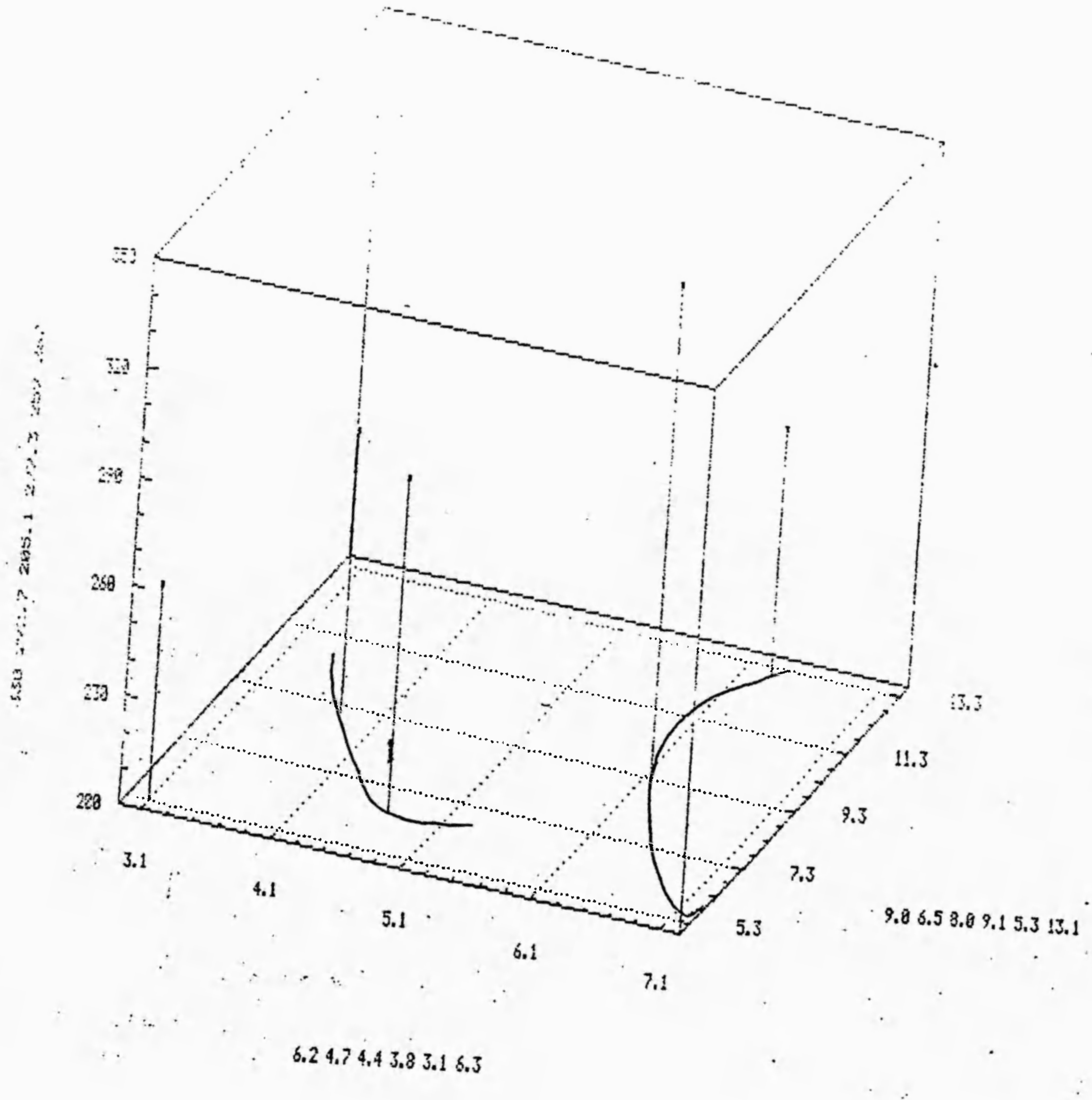
(iii) 2100-2500 thousand private arable tonnes



(i) 10-20 thousand (former) state arable tonnes



(ii) 80-200 thousand (former) state arable tonnes



(iii) 200-350 thousand (former) state arable tonnes

VII.2 Tests for convexity

As documented in Chapter 3, the isoquants of the Cobb Douglas production function are strictly convex to the origin and downward sloping. Strict convexity can be determined from the signs of the derivatives dK/dL and d^2L/dK^2 (or dL/dK and d^2K/dL^2). For any positive output, Q_o, [3.13] can be expressed as:

$$AK^{\alpha}L^{\beta}=Q_0 \qquad \text{[VII.1]}$$

as long as A, K, L, Q_0 are >0, and α and β are positive fractions.

Taking natural log of both sides and transposing, we find that

$$\ln A+\alpha\ln K+\beta\ln L-\ln Q_0=0 \qquad \text{[VII.2]}$$

Replacing the α and β values in equation [VII.2] with the national empirical results derived from this investigation, equations [VII.3] and [VII.4] are the private and (former) state national functions:

$$\ln A+0.172\ln K+0.106\ln L-\ln Q_0=0 \qquad \text{[VII.3]}$$

$$\ln A+0.420\ln K+0.081\ln L-\ln Q_0=0 \qquad \text{[VII.4]}$$

which implicitly define K as a function of L. By the implicit function rule[566] and the log rule, therefore, we have

$$\frac{dK}{dL}=-\frac{\delta F/\delta L}{\delta F/\delta K}=-\frac{\beta(\frac{1}{L})}{\alpha(\frac{1}{K})}=-\frac{(\beta/L)}{(\alpha/K)}=-\frac{\beta K}{\alpha L}<0 \qquad \text{[VII.5]}$$

[566]In general, the implicit function rule can be described as: $F(y, x_1..., x_m)=0$, if an implicit function $y=f(x_1..x_m)$ exists, then the partial derivatives of f are: $\delta y/\delta x_i = -Fi/F_y$. (i=1,2,..m). In the simple case when the given equation is F(y,x)=0, the rule gives $dy/dx=-F_x/F_y$. Thus for the equation F(Q,L,K)=0, the marginal products are the partial derivatives, i.e. δQ/δK, δQ/δL and δK/δL, we can apply the implicit function rule and write $MPP_K=\delta Q/\delta K= -F_K/F_Q$, $MPP_L=\delta Q/\delta L= -F_L/F_Q$ and $\delta K/\delta L =-F_L/F_K$ (Chiang, 1984).

$$\frac{dK}{dL}=-\frac{\delta F/\delta L}{\delta F/\delta K}=-\frac{0.106(\frac{1}{L})}{0.172(\frac{1}{K})}=-\frac{(0.106/L)}{(0.172/K)}=-\frac{0.106K}{0.172L}=-0.616\frac{K}{L}<0 \qquad [VII.6]$$

$$\frac{dK}{dL}=-\frac{\delta F/\delta L}{\delta F/\delta K}=-\frac{0.081(\frac{1}{L})}{0.420(\frac{1}{K})}=-\frac{(0.081/L)}{(0.420/K)}=-\frac{0.081K}{0.420L}=-0.193\frac{K}{L}<0 \qquad [VII.7]$$

Then it follows that[625] the second derivatives for the private and (former) state sectors are:

$$\frac{d^2K}{dL^2}=\frac{d}{dL}-(0.616)(\frac{K}{L})=-(0.616)(\frac{d}{dL})(\frac{K}{L})=-(0.616)\frac{1}{L^2}(L\frac{dK}{dL}-K)=>0 \qquad [VII.8]$$

$$\frac{d^2K}{dL^2}=\frac{d}{dL}-(0.193)(\frac{K}{L})=-(0.193)(\frac{d}{dL})(\frac{K}{L})=-(0.193)\frac{1}{L^2}(L\frac{dK}{dL}-K)=>0 \qquad [VII.9]$$

As dK/dL were less than zero (derived in equations [VII.6] and [VII.7]), then d^2K/dL^2 must be positive for both sectors. Thus, the positive second derivatives establish that the isoquants (any isoquant) of this Cobb Douglas production function of national Polish arable farming are downward-sloping throughout and strictly convex in the LK plane for positive values of L and K.

This rule applies if both elasticity coefficients, α and β are positive. However, a number of regional Cobb Douglas production functions of Polish arable farming (1989-1993) in this empirical investigation generated negative labour (β) elasticity coefficients. In these cases, dK/DL (as in for example, equations [VII.6] and [VII.7]) would actually have been more than zero and, the second derivatives would have been less than zero, accordingly. Therefore, the isoquant (any isoquant) of these regions may be upward-sloping, and even concave in the LK plane for positive values of L and K. One explanation for this unanticipated result could

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[567]Using the quotient rule of differentiation.

be inadequate data and/or small sample distributions. More seriously, if the isoquants are really concave at this point in time, and an inefficient combination of resources are used in the processes of production (perhaps due to imperfect information and unreliable price signals during economic transition) then a Cobb Douglas model of production may not be the most appropriate model to fit to Polish secondary regional data. One possible way of testing would be to conduct a similar investigation during a subsequent time period, if the data are available and accessible. The regions which generated negative aggregate labour elasticity coefficients were the private southern regions (southeast and southwest) and the (former) state northwest (detailed in Chapters 6 and 7).

Appendix VIII

Model Specifications for International, National and Polish Agricultural Production Functions (refer to Chapter 7)

Author	Specification of Variables included within the models
Bhattacharjee (1955)	1, 11, 19, 29, 36, 40
Hayami and Ruttan (1971, 1985)	2, 12, 21, 29, 36, 42, 48
Evenson and Kislev (1975)	2, 12, 21, 29, 36, 42, 48
Nguyen (1979)	2, 12, 21, 29, 36, 42, 48
Yamada and Ruttan (1980)	2, 12, 21, 29, 36, 42, 48
Antle (1983)	1, 12, 29, 36, 42, 54, 55
Kawogoe, Hayami and Ruttan (1985)	2, 12, 21, 29, 36, 42, 48
Lau and Yotopoulos (1968)	2, 12, 21, 29, 36, 42, 48
Yotopoulos (1968)	3, 13, 22, 23, 37, 43, 49

Author	Specification of Variables included within the models
Wong (1986)	4, 14, 24, 30, 38, 44, 50, 51, 52
Wong and Ruttan (1983)	n.a.
Clayton (1980)	5, 15, 21, 31, 39, 43
Brooks (1983)	n.a.
Johnson et al. (1994)	6, 15, 25, 45, 56
Fleisher and Liu (1992)	7, 16, 26, 32, 43, 53
Lin (1992)	n.a.
Boyd (1988, 1991)	8, 17, 27, 33, 46
Florkowski, Hill and Zareba (1988)	9, 15, 19, 28, 34, 47, 57, 58, 59, 60
Screene	10, 18, 20, 35, 41

n.a. denotes not available

Output

1=Total value, in US $million (net intermediate products)

2=Total value, in million wheat units (net intermediate products)

3=Total value, in drachmas

4=Total value from private, socialist and cooperative farms based upon 1960 prices 5=Total value, in Russian rubles million at 1965 prices (plus intermediate products)

6=Total Value, in Ukrainian rubles of marketed production of four separate crops (potatoes, corn, grains, sugar beets)

7=Total value in weighted rice-equivalent kilograms (weights are based on the parity price ratio of agricultural and industrial products in the Statistical Yearbook of China, 1987)

8=Gross agricultural production at 1977 prices

9=Total value, in 1000 arable tonnes (wheat, rye, barley, oats)

10=Total value, in 1000 arable tonnes (wheat, rye, barley, oats, potatoes, rapeseed, sugar beets)

Land

11=Weighted arable land, 1000 hectares

12=Arable and Pasture land, in 1000 hectares

13=The number of stremmata cultivated. One stremmata equals 0.10 hectares

14=Total area of arable land, permanent crop land, permanent pasture and meadows, in hectares. Arable land of the above is defined as total area of arable land and land under permanent crops. It is a subset of LAND and refers to land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens (including cultivation under glass), and land temporarily fallow or lying idle. Land under permanent crops refers to land cultivated with crops which occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. It includes land under shrubs, fruit trees, nut trees and vines, but excludes land under trees grown for wood or timber.

15=Cultivated land under crops, in hectares

16=Family crop area measured in *mu* (0.07 hectares)

17=Land is in hectares of arable land, adjusted for regional quality differences 18=Cultivated land under crops, in 1000 hectares

Capital

19=Number of tractors

20=Number of tractors, in 1000s

21=Horsepower equivalent of all tractors

22=Value of current services of plant plus operating services (houses, irrigation, ditches, etc.), in drachmas

23=Value of equipment (tractors, implements, etc.), in drachmas

24=Agricultural machinery is defined as the total number of wheel and crawler tractors (excluding the garden tractors) used in agriculture. In Eastern Europe, tractors were reported in terms of 15 HP. In order to be consistent with the assumption that large tractors are 30 HP and small tractors are 5 HP, the figures of 15 HP are converted into 30 HP. When information on 15 HP tractors was unobtainable, the number of tractors was used instead. Since statistics on small tractors were unavailable, the same number of large tractors was assumed instead. In addition, the number of horses actively used in agricultural production were equal to 1 tractor (15 HP).

25=Total cost of production net of wages (1000 Ukrainian rubles)

26=Monetary expenditure on pesticides, seeds, hired machinery, and hired animals

27=Tractive horsepower (average=35 HP), a combined index of the private and state sector inventories

28=Horse inventories

Fertilisers

29=1000 tonnes of nitrogen, phosphate and potash

30=Chemical fertiliser defined as the gross weight of total consumption of nitrogenous, phosphate, and potash (N_2 + P_2O_5 + K_2O) measured in metric tons

31=Fertiliser in tons, adjusted to 100 per cent nutrients

32=Monetary Expenditure on pesticides, seeds, hired machinery, and hired animals

33=Tons of chemical fertiliser consumed, a combined index of private and state sector inventories

34=Fertiliser use calculated by multiplying 'hectares planted by fertiliser used per hectare'

35=Chemical fertiliser defined as the gross weight of total consumption of nitrogenous, phosphate, and potash (N_2 + P_2O_5 + K_2O) measured in kilogram per cultivated hectare

Livestock

36=Animal equivalent weighting scheme

37=Value of current services of live capital plus operating expenses for live capital, in drachmas

38=Livestock in units, weighted by the FAO conversion factors. Conversion factors are camels: 1.1; buffalo, horse, and mules 1.0; cattle and asses: 0.8; pigs: 0.2; sheep and goats: 0.1; and poultry: 0.01.

39=Annual inventory of livestock used for productive purposes, adjusted to a cattle-equivalent unit from a Soviet handbook. The variable includes cattle, cows, swine, sheep, goats, and poultry.

Labour

40=All agricultural labourers

41=All agricultural labourers, in 1000s

42=Male agricultural labourers only

43=Labour-days worked

44=Economically active population including all working farmers, their wives working in agriculture, helping members, and hired labour measured in full-time man-years

45=1000 man-hours

46=Total agricultural labour force, less social sector, adjusted for changes in the age and sex composition

47=Deflated wage on seasonal labour on private farms

Non-conventional Inputs

Education and Research

48=A proxy for education and research

49=Average years of education per farm worker

50=Agricultural research is defined as the manpower involved in agricultural research measured in scientific man-years.

51=Rural population is defined as all persons actively engaged in agriculture and their non-working dependents.

52=School enrolment ratio defined as the number of students enrolled in the first and second levels of the population of potential enrolment.

53=Years of schooling and years of farming experience

Other

54=Portion of Gross Domestic Product (GDP) spent on transportation and communications

55=Includes potential dry matter; factor of water deficit; capital (as gauged by per capita production levels); and ratio livestock/total agricultural output

56=Time trend

57=Deflated Investment Credit for private and cooperative sectors

58=New buildings for livestock for socialised sector

59=Commercial feed supply

60=Binary Variable indicating increased US feed grain exports to Poland

Appendix IX: Regional GLS Regressions (1988-1993)

Table IX.1: Regression results for the private sector (Northwest) using GLS

	M=1989		M=1990		M=1991	
	p1	p2	p1	p2	p1	p2
C[a]	3.108 (0.689)	7.478 (1.578)	4.162 (1.274)	2.484 (1.227)	0.118 (0.163)	0.446 (-1.261)
N	0.582 (2.680)	0.433 (3.578)	0.375 (2.379)	0.381 (3.521)	0.508 (3.884)	0.538 (4.949)
K	0.685 (4.024)	0.772 (5.765)	0.780 (5.133)	0.707 (6.281)	0.402 (3.412)	0.428 (4.176)
F	-0.199 (-1.666)	-0.208 (-1.753)	-0.109 (-1.151)	-0.065 (-0.460)	0.126 (3.200)	0.263 (2.446)
L	0.218 (0.454)	0.306 (0.722)	0.161 (1.895)	0.229 (2.986)	0.426 (5.944)	0.468 (7.002)
R	0.341 (2.171)	0.266 (2.041)	0.249 (3.459)	0.229 (2.986)	0.144 (1.924)	0.269 (3.667)
DN	-0.214 (-0.806)	n.a.	0.039 (0.173)	n.a.	0.253 (0.333)	n.a.
DK	-0.514 (-2.440)	-0.639 (-3.96)	-0.282 (-1.205)	n.a.	0.018 (0.071)	n.a.
DF	0.360 (3.024)	0.374 (3.170)	0.148 (1.415)	n.a.	-0.123 (-1.580)	n.a.
DL	0.872 (5.194)	0.822 (5.402)	0.419 (2.443)	0.191 (2.768)	0.355 (-0.514)	n.a.
DR	0.558 (3.117)	0.620 (3.780)	0.568 (5.214)	0.604 (5.657)	0.970 (8.913)	0.805 (7.708)
d	-6.690 (-3.847)	-7.640 (-5.798)	-5.537 (-4.402)	-4.790 (-6.275)	-6.285 (-5.929)	-5.188 (-8.040)
R^2	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratios $< \pm 2$)
[Source: Compiled by Author]

Table IX.2: Regression results for the private sector (Northeast) using GLS

	M=1989			M=1990		M=1991	
	p1	p2	p3	p1	p2	p1	p2
C[a]	619.554 (4.016)	3.973 (5.062)	25.636 (3.566)	186.606 (5.378)	25.636 (3.566)	35.481 (3.234)	25.636 (3.566)
N	0.691 (7.021)	0.776 (1.089)	0.759 (12.874)	0.758 (12.769)	0.759 (12.874)	0.764 (10.334)	0.759 (12.874)
K	0.120 (1.980)	0.237 (1.085)	0.339 (1.494)	0.127 (3.278)	0.339 (1.494)	0.367 (1.639)	0.339 (1.494)
F	-0.243 (-0.996)	-0.257 (-1.420)	-0.028 (-0.155)	-0.130 (-1.002)	-0.028 (-0.155)	0.118 (0.394)	-0.028 (-0.155)
L	0.396 (1.447)	0.485 (4.849)	0.602 (5.837)	-0.330 (2.646)	0.602 (5.837)	0.575 (3.985)	0.602 (5.837)
R	-0.558 (-1.954)	-0.420 (-3.290)	-0.450 (-3.271)	-0.476 (-3.073)	-0.450 (-3.271)	-0.521 (-3.113)	-0.450 (-3.271)
DN	0.327 (1.631)	0.198 (0.586)	n.a.	0.304 (0.453)	n.a.	0.073 (0.249)	n.a.
DK	-0.312 (-1.203)	n.a.	n.a.	-0.085 (-0.316)	n.a.	0.104 (0.214)	n.a.
DF	0.172 (0.684)	n.a.	n.a.	-0.119 (-0.234)	n.a.	-0.212 (-1.644)	n.a.
DL	0.164 (0.148)	n.a.	n.a.	-0.232 (-0.395)	n.a.	-0.126 (-0.533)	n.a.
DR	0.472 (1.359)	n.a.	n.a.	0.302 (1.497)	n.a.	0.253 (0.625)	n.a.
d	-4.885 (-2.495)	-0.378 (-0.884)	n.a.	-2.563 (-1.783)	n.a.	-0.472 (-0.188)	n.a.
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratios $< \pm 2$)
[Source: Compiled by Author]

Table IX.3: Regression results for the private sector (Southeast) using GLS

	M=1989		M=1990		M=1991	
	p1	p2	p1	p2	p1	p2
C[a]	6304.38 (8.708)	6210.52 (8.937)	1064.22 (12.032)	540.773 (12.596)	42.649 (0.537)	32.753 (6.518)
N	0.464 (3.990)	0.477 (6.155)	0.474 (6.188)	0.512 (8.042)	0.705 (8.660)	0.719 (11.420)
K	0.562 (2.329)	0.528 (4.816)	0.726 (5.017)	0.778 (6.684)	0.617 (3.653)	0.522 (4.054)
F	-0.204 (-1.667)	-0.203 (-1.827)	-0.184 (-1.060)	0.038 (0.275)	0.232 (7.890)	0.217 (10.298)
L	0.216 (0.382)	0.295 (0.771)	-0.359 (-1.222)	-0.222 (-3.682)	-0.272 (-2.807)	-0.231 (-3.278)
R	-0.754 (-4.637)	-0.762 (-4.818)	-0.568 (-7.226)	0.326 (2.365)	-0.230 (-2.698)	-0.248 (-3.070)
DN	0.329 (2.356)	0.310 (3.781)	0.118 (1.056)	n.a.	-0.130 (-0.970)	n.a.
DK	-0.182 (-0.193)	n.a.	-0.167 (-0.287)	n.a.	0.137 (0.636)	n.a.
DF	0.408 (3.392)	0.408 (3.711)	0.161 (3.051)	0.326 (2.365)	-0.102 (-1.630)	n.a.
DL	0.347 (-2.227)	-0.376 (-4.058)	-0.147 (-1.941)	n.a.	-0.148 (-0.364)	n.a.
DR	0.620 (3.263)	0.628 (3.380)	0.160 (1.340)	n.a.	0.068 (0.341)	n.a.
d	-6.001 (-4.930)	-5.968 (-5.028)	-1.811 (-2.068)	-0.655 (-3.366)	0.753 (0.537)	n.a.
R^{2b}	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratios < ±2)
[Source: Compiled by Author]

Table IX.4: Regression results for the private sector (Southwest) using GLS

	M=1989		M=1990		M=1991	
	p1	p2	p1	p2	p1	p2
C[a]	41.89 (2.214)	42.91 (2.746)	12.64 (2.142)	13.29 (2.755)	11.93 (2.566)	5.58 (1.937)
N	0.535 (2.684)	0.668 (4.956)	0.718 (5.190)	0.758 (7.498)	0.730 (5.884)	0.832 (7.671)
K	0.263 (1.250)	0.242 (0.701)	0.230 (1.529)	0.149 (1.515)	0.256 (2.156)	0.132 (1.383)
F	0.308 (3.620)	0.181 (5.940)	0.208 (3.284)	0.137 (3.609)	0.170 (5.473)	0.167 (5.865)
L	0.416 (3.569)	0.430 (3.931)	0.212 (2.654)	0.217 (2.733)	0.182 (3.057)	0.186 (2.980)
R	-0.594 (-3.032)	-0.503 (-2.607)	-0.286 (-2.040)	-0.277 (-1.748)	-0.243 (-1.922)	-0.143 (-3.844)
DN	-0.824 (3.334)	0.595 (4.219)	0.647 (2.878)	0.458 (3.835)	-0.488 (-3.887)	0.445 (3.311)
DK	-0.328 (-1.316)	n.a.	-0.257 (-1.238)	n.a.	-0.332 (-1.680)	n.a.
DF	-0.137 (-1.482)	n.a.	-0.289 (-1.089)	n.a.	0.107 (0.136)	n.a.
DL	-0.601 (-4.468)	-0.628 (-4.780)	-0.470 (-4.031)	-0.465 (-3.968)	0.750 (3.138)	-0.475 (-3.844)
DR	0.855 (3.542)	0.694 (3.150)	0.650 (2.697)	0.442 (2.231)	0.893 (3.163)	0.647 (2.701)
d	-5.046 (-2.490)	-4.552 (-3.109)	-4.135 (-2.205)	-3.134 (-2.498)	-6.352 (-3.064)	-4.319 (-2.889)
R^2	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratios $< \pm 2$)

[Source: Compiled by Author]

Table IX.5: Regression results for the (former) state sector (Northwest) using GLS

	M=1989		M=1990		M=1991	
	s1	s2	s1	s2	s1	s2
C[a]	0.834 (-0.900)	0.547 (-2.730)	0.532 (-0.402)	1.438 (0.477)	2.016 (0.805)	1.185 (0.260)
N	1.179 (5.575)	1.126 (8.469)	0.938 (5.927)	0.772 (9.485)	0.771 (6.224)	0.747 (10.683)
K	0.650 (1.826)	0.583 (3.819)	0.205 (0.761)	0.242 (1.396)	0.171 (0.190)	0.336 (1.922)
F	0.611 (2.971)	0.427 (7.300)	0.581 (3.121)	0.429 (6.209)	0.475 (4.557)	0.514 (7.220)
L	-0.761 (-2.237)	-0.718 (-3.375)	-0.169 (-0.786)	0.100 (0.239)	0.137 (0.680)	-0.364 (-0.323)
R	-0.107 (-0.167)	0.164 (2.198)	-0.168 (-1.478)	-0.154 (-1.745)	-0.248 (-3.161)	-0.192 (-2.695)
DN	-0.540 (-2.406)	-0.393 (-2.912)	-0.374 (-2.111)	-0.116 (-3.028)	-0.127 (-0.849)	n.a.
DK	-0.275 (-0.737)	n.a.	0.143 (0.439)		0.315 (0.986)	n.a.
DF	-0.269 (-1.269)	n.a.	-0.207 (-1.026)	n.a.	-0.214 (-0.380)	n.a.
DL	0.821 (2.293)	0.569 (2.723)	0.275 (1.072)	n.a.	-0.131 (-0.558)	n.a.
DR	0.334 (1.750)	n.a.	0.447 (3.080)	0.428 (3.326)	0.710 (5.714)	0.714 (6.293)
d	0.348 (0.167)	n.a.	-0.868 (-0.514)	-2.178 (-2.802)	-3.744 (-3.068)	-4.386 (-6.372)
R^2	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parenthesis
n.a. denotes restriction=zero (as t-ratios $< \pm 2$)
[Source: Compiled by Author]

Table IX.6: Regression results for the (former) state sector (Northeast) using GLS

	M=1989			M=1990		M=1991	
	s1	s2	s3	s1	s2	s1	s2
C[a]	0.700 (-0.100)	394.256 (4.102)	366.134 (4.261)	10.176 (0.735)	1680.76 (5.377)	141.600 (3.961)	303.992 (4.406)
N	1.308 (2.028)	0.279 (2.401)	0.297 (2.587)	1.331 (3.173)	0.548 (4.184)	0.789 (4.273)	0.566 (3.788)
K	-2.032 (-1.679)	0.278 (0.826)	0.247 (0.769)	-1.763 (-2.154)	-0.457 (-1.099)	-0.900 (-1.969)	-0.402 (-1.050)
F	0.759 (1.975)	0.339 (1.011)	0.271 (0.917)	0.301 (1.193)	-0.247 (-0.766)	0.113 (0.861)	0.224 (0.629)
L	0.898 (3.827)	0.847 (5.095)	0.848 (5.185)	0.783 (3.095)	0.970 (5.875)	0.943 (4.949)	0.892 (5.025)
R	-0.504 (-1.005)	-0.760 (-3.451)	-0.734 (-3.440)	-0.518 (-1.779)	-0.869 (-4.573)	0.690 (-3.507)	-0.723 (-3.631)
DN	-1.144 (-1.746)	n.a.	n.a.	-1.287 (-2.981)	-0.496 (-3.468)	-0.926 (-3.893)	-0.452 (-2.712)
DK	2.919 (2.307)	0.057 (0.190)	n.a.	2.525 (2.481)	1.173 (3.342)	2.082 (2.679)	1.171 (2.948)
DF	-0.728 (-1.824)	n.a.	n.a.	-0.363 (-1.357)	n.a.	-0.271 (-0.441)	n.a.
DL	-0.255 (-0.799)	n.a.	n.a.	0.178 (0.442)	n.a.	0.167 (0.106)	n.a.
DR	-0.265 (-0.455)	n.a.	n.a.	-0.181 (-0.357)	n.a.	-0.953 (-1.196)	n.a.
d	6.750 (1.672)	n.a.	n.a.	3.978 (0.939)	n.a.	6.941 (1.365)	n.a.
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratios $< \pm 2$)
[Source: Compiled by Author]

Table IX.7: Regression results for the (former) state sector (Southeast) using GLS

	M=1989			M=1990			M=1991	
	s1	s2	s3	s1	s2	s3	s1	s2
C^a	12.118 (4.104)	10.640 (4.008)	6.075 (6.396)	8.924 (2.411)	11.946 (6.837)	11.600 (7.725)	8.419 (8.005)	8.521 (9.992)
N	0.650 (6.930)	0.685 (7.643)	0.838 (27.481)	0.751 (6.178)	0.745 (11.699)	0.749 (12.338)	0.781 (15.965)	0.812 (21.731)
K	0.049 (0.215)	0.230 (1.963)	0.360 (3.203)	-0.397 (-0.936)	0.469 (2.509)	0.476 (2.956)	0.061 (0.367)	0.108 (0.877)
F	0.536 (3.445)	0.491 (3.239)	0.406 (3.178)	0.784 (2.394)	0.309 (1.108)	0.362 (1.618)	0.318 (4.877)	0.243 (5.495)
L	0.903 (2.875)	0.697 (2.728)	0.268 (1.847)	0.744 (2.253)	0.164 (0.199)	-0.047 (-0.123)	0.539 (3.842)	0.437 (3.602)
R	-2.271 (-4.506)	-1.984 (-4.540)	-1.153 (-7.294)	1.968 (-4.775)	-1.742 (-6.500)	-1.699 (-7.222)	-1.447 (-8.458)	-1.393 (-9.787)
DN	0.200 (2.020)	0.180 (1.842)	n.a.	0.141 (0.259)	n.a.	n.a.	0.291 (0.943)	n.a.
DK	0.302 (1.123)	n.a.	n.a.	0.854 (1.822)	n.a.	n.a.	0.103 (0.419)	n.a.
DF	-0.505 (-3.256)	-0.468 (-3.067)	-0.366 (-3.051)	-0.690 (-2.039)	0.038 (-0.294)	n.a.	-0.135 (-1.574)	n.a.
DL	-0.834 (-2.573)	-0.608 (-2.386)	-0.210 (-1.491)	-0.775 (-2.239)	-0.217 (-0.294)	n.a.	-0.291 (-2.479)	-0.282 (-1.915)
DR	1.597 (2.952)	1.285 (2.741)	0.370 (2.991)	0.826 (1.450)	1.334 (4.883)	n.a.	0.955 (3.122)	0.854 (3.107)
d	-6.689 (-2.117)	-5.026 (-1.789)	n.a.	-0.779 (-0.172)	-6.078 (-3.521)	-5.109 (-2.959)	-4.773 (-2.469)	-4.801 (-2.914)
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratios $< \pm 2$)
[Source: Compiled by Author]

Table IX.8: Regression results for the (former) state sector (Southwest) using GLS

	M=1989			M=1990		M=1991	
	s1	s2	s3	s1	s2	s1	s2
C[a]	52.248 (1.796)	82.930 (5.143)	77.867 (5.149)	27.440 (2.285)	4.933 (1.849)	137.140 (4.590)	277.550 (6.009)
N	0.418 (3.588)	0.556 (5.692)	0.605 (8.609)	0.322 (3.493)	0.390 (4.717)	0.278 (3.962)	0.285 (4.286)
K	0.442 (2.491)	0.404 (4.885)	0.414 (4.978)	0.526 (4.475)	0.416 (5.256)	0.574 (5.960)	0.567 (5.933)
F	0.439 (1.548)	0.170 (0.819)	0.272 (1.307)	0.641 (3.758)	0.769 (5.836)	0.388 (3.227)	0.298 (4.362)
L	0.610 (4.019)	0.499 (4.215)	0.461 (4.214)	0.648 (6.271)	0.607 (6.474)	0.729 (8.116)	0.754 (8.233)
R	-0.783 (-3.591)	-0.490 (-3.963)	-0.524 (-4.192)	-0.865 (-5.991)	-0.722 (-5.921)	-0.873 (-6.754)	-0.906 (-6.804)
DN	0.395 (3.193)	0.256 (2.572)	0.195 (2.648)	0.519 (5.161)	0.407 (4.881)	0.651 (7.543)	0.636 (7.813)
DK	-0.300 (-0.404)	n.a.	n.a.	-0.242 (-1.531)	n.a.	-0.343 (-2.140)	-0.349 (-2.141)
DF	-0.395 (-1.369)	n.a.	n.a.	-0.347 (-1.925)	-0.485 (-3.594)	-0.125 (-0.863)	n.a.
DL	-0.460 (-2.820)	-0.393 (-3.030)	-0.367 (-3.002)	-0.519 (5.161)	-0.560 (-5.161)	-0.703 (-5.518)	-0.717 (-5.610)
DR	0.553 (2.164)	-0.092 (-1.224)	n.a.	0.819 (3.733)	0.472 (3.765)	0.891 (3.778)	0.916 (4.011)
d	-1.319 (-0.550)	n.a.	n.a.	-3.074 (-1.675)	n.a.	-5.065 (-3.168)	-5.891 (-4.079)
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99

[a] denotes anti-logged; t-ratios (from zero) at five per cent significance level in parentheses
n.a. denotes restriction=zero (as t-ratios $< \pm 2$)
[Source: Compiled by Author]

Appendix X: Early-Transition aggregate production elasticity coefficients at alternative breakpoints: 1990-1993 and 1991-1993

Table X.1: Early-transition national regression results for the private and (former) state sectors using GLS (1990-1993)

	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	Private			(Former) state		
I	17.357 (6.697)	-2.229 (-3.072)	15.128	6.141 (4.235)	n.a.	6.141 (4.235)
N	0.842 (21.803)	n.a.	0.842 (21.803)	0.645 (14.685)	0.107 (2.391)	0.752
K	0.299 (6.612)	n.a.	0.299 (6.612)	0.305 (6.130)	n.a.	0.305 (6.130)
F	0.230 (1.415)	n.a.	0.230 (1.415)	0.505 (7.094)	-0.221 (-2.992)	0.285
L	0.070 (0.758)	n.a.	0.070 (0.758)	0.338 (6.054)	-0.242 (-3.928)	0.096
R	-0.160 (-2.786)	0.288 (3.717)	0.128	-0.606 (-8.438)	0.671 (6.666)	0.065

Table X.2: Early-transition national regression results for the private and (former) state sectors using GLS (1991-1993)

	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	Private			(Former) state		
I	4.293 (3.373)	-2.760 (-4.446)	1.533	27.855 (6.981)	-3.974 (-5.346)	23.881
N	0.898 (22.329)	n.a.	0.898 (22.329)	0.592 (15.247)	0.171 (3.956)	0.763
K	0.162 (3.766)	n.a.	0.162 (3.766)	0.361 (6.816)	n.a.	0.361 (6.816)
F	0.150 (8.469)	-0.110 (-3.919)	0.04	0.365 (9.371)	-0.125 (-2.549)	0.24
L	0.127 (4.587)	n.a.	0.127 (4.587)	0.375 (8.224)	-0.338 (-5.280)	0.037
R	-0.110 (-1.934)	0.513 (5.371)	0.403	-0.619 (-9.886)	0.777 (7.542)	0.158

n.a.denotes restriction=zero (as t-ratios <±2)

N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall

[Source: Compiled by Author]

Table X.3: Early-transition GLS regression results generated by the private sector. by regions (1990-1993)

	Private					
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	NW			NE		
I	2.484 (1.227)	-4.790 (-6.275)	-2.306	25.636 (3.566)	n.a.	25.636 (3.566)
N	0.381 (3.521)	n.a.	0.381 (3.521)	0.759 (12.874)	n.a.	0.759 (12.874)
K	0.707 (6.281)	-0.631 (-3.969)	0.707 (6.281)	0.339 (1.494)	n.a.	0.339 (1.494)
F	-0.065 (-0.460)	n.a.	-0.065 (-0.460)	-0.028 (-0.155)	n.a.	-0.028 (-0.155)
L	0.229 (2.986)	0.191 (2.768)	0.42	0.602 (5.837)	n.a.	0.602 (5.837)
R	0.229 (2.986)	0.604 (5.657)	0.833	-0.450 (-3.271)	n.a.	-0.450 (-3.271)
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	SW			SE		
I	13.29 (2.755)	-3.134 (-2.498)	10.156	540.773 (12.032)	-0.655 (-3.366)	540.118
N	0.758 (7.498)	0.458 (3.835)	1.216	0.512 (8.042)	n.a.	0.512 (8.042)
K	0.149 (1.515)	n.a.	0.149 (1.515)	0.778 (6.684)	n.a.	0.778 (6.684)
F	0.137 (3.609)	n.a.	0.137 (3.609)	0.038 (0.275)	0.326 (2.365)	0.364
L	0.217 (2.733)	-0.465 (-3.968)	-0.248	-0.222	n.a.	-0.222
R	-0.143 (-3.844)	0.647 (2.701)	0.504	0.326 (2.365)	n.a.	0.326 (2.365)

t-ratios (from zero) at five per cent significance level in parentheses;
n.a.denotes restriction=zero (as t-ratios <±2);
I=intercept; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall;
NW=Northwest; NE=Northeast; SE=Southeast; SW=Southwest
[Source: Compiled by Author]

Table X.4: Early-transition GLS regression results generated by the private sector. by regions (1991-1993)

	Private					
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	NW			NE		
I	0.446 (-1.261)	-5.188 (-8.040)	-4.742	25.636 (3.566)	n.a.	25.636 (3.566)
N	0.538 (4.949)	n.a.	0.538 (4.949)	0.759 (12.874)	n.a.	0.759 (12.874)
K	0.428 (4.176)	n.a.	0.428 (4.176)	0.339 (1.494)	n.a.	0.339 (1.494)
F	0.263 (2.446)	n.a.	0.263 (2.446)	-0.028 (-0.155)	n.a.	-0.028 (-0.155)
L	0.468 (7.002)	n.a.	0.468 (7.002)	0.602 (5.837)	n.a.	0.602 (5.837)
R	0.269 (3.667)	0.805 (7.708)	1.074	-0.450 (-3.271)	n.a.	-0.450 (-3.271)
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	SW			SE		
I	5.580 (1.937)	-4.319 (-2.889)	1.261	32.753 (6.518)	n.a.	32.753 (6.518)
N	0.832 (7.671)	0.445 (3.311)	1.277	0.719 (11.420)	n.a.	0.719 (11.420)
K	0.132 (1.383)	n.a.	0.132 (1.383)	0.522 (4.054)	n.a.	0.522 (4.054)
F	0.167 (5.865)	n.a.	0.167 (5.865)	0.217 (10.298)	n.a.	0.217 (10.298)
L	0.186 (2.980)	-0.475 (-3.844)	-0.289	-0.231 (-3.278)	n.a.	-0.231 (-3.278)
R	-0.143 (-3.844)	0.647 (2.701)	0.504	-0.248 (-3.070)	n.a.	-0.248 (-3.070)

t-ratios (from zero) at five per cent significance level in parentheses;
n.a.denotes restriction=zero (as t-ratios <±2);
I=intercept; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall;
NW=Northwest; NE=Northeast; SE=Southeast; SW=Southwest
[Source: Compiled by Author]

Table X.5: Early-transition GLS regression results generated by the (former) state sector, by regions (1990-1993)

	(Former) state					
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	NW			NE		
I	1.438 (0.477)	-2.178 (-2.802)	-1.815	1680.76 (5.377)	n.a.	1680.76 (5.377)
N	0.772 (9.485)	-0.116 (-3.028)	0.656	0.548 (4.184)	-0.496 (-3.468)	0.052
K	0.242 (1.396)	0.143 (0.439)	0.242	-0.457 (-1.099)	1.173 (3.342)	0.716
F	0.429 (6.209)	n.a.	0.429 (6.209)	-0.247 (-0.766)	n.a.	-0.247 (-0.766)
L	0.100 (0.239)	n.a.	0.100	0.970 (5.875)	n.a.	0.970 (5.875)
R	-0.154 (-1.745)	0.428 (3.326)	0.274	-0.869 (-4.573)	n.a.	-0.869 (-4.573)
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	SW			SE		
I	4.933 (1.849)	n.a.	4.933 (1.849)	11.600 (7.725)	-5.959 (-2.959)	5.868
N	0.390 (4.717)	0.407 (4.881)	0.797	0.749 (12.338)	n.a.	0.749 (12.338)
K	0.416 (5.256)	n.a.	0.416 (5.256)	0.476 (2.956)	n.a.	0.476 (2.956)
F	0.769 (5.836)	-0.485 (-3.594)	0.284	0.362 (1.618)	n.a.	0.362 (1.618)
L	0.607 (6.474)	-0.560 (-5.161)	0.047	-0.047 (-0.123)	n.a.	-0.047 (-0.123)
R	-0.722 (-5.921)	0.472 (3.765)	-0.250	-1.691 (-7.222)	n.a.	-1.691 (-7.222)

t-ratios (from zero) at five per cent significance level in parentheses;
n.a.denotes restriction=zero (as t-ratios <±2);
I=intercept; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall;
NW=Northwest; NE=Northeast; SE=Southeast; SW=Southwest

[Source: Compiled by Author]

Table X.6: Early-transition GLS regression results generated by the (former) state sector, by regions (1991-1993)

	(Former) state					
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	NW			NE		
I	1.185 (0.260)	-4.386 (-6.372)	-3.201	303.992 (4.406)	n.a.	303.992 (4.406)
N	0.747 (10.683)	n.a.	0.747	0.566 (3.788)	-0.452 (-2.712)	0.114
K	0.336 (1.922)	n.a.	0.336 (1.922)	-0.402 (-1.050)	1.171 (2.948)	0.769
F	0.514 (7.220)	n.a.	0.514 (7.220)	0.224 (0.629)	n.a.	0.224 (0.629)
L	-0.364 (-0.323)	n.a.	-0.364 (-0.323)	0.892 (5.025)	n.a.	0.892 (5.025)
R	0.164 (2.198)	n.a.	0.522	-0.723 (-3.631)	n.a.	-0.723 (-3.631)
	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities	Production Elasticity Coefficients	Dummy Variables	Aggregate Production Elasticities
	SW			SE		
I	277.550 (6.009)	-5.891 (-4.079)	271.66	11.600 (7.725)	-5.109 (-2.959)	5.868
N	0.285 (4.286)	0.636 (7.813)	0.921	0.812 (21.731)	n.a.	0.812 (21.731)
K	0.567 (5.933)	-0.349 (-2.141)	0.218	0.108 (0.877)	n.a.	0.108 (0.877)
F	0.298 (4.362)	n.a.	0.298 (4.362)	0.243 (5.495)	n.a.	0.243 (5.495)
L	0.754 (8.233)	-0.717 (-5.610)	0.037	0.437 (3.602)	-0.282 (-1.915)	0.155
R	-0.906 (-6.804)	0.916 (4.011)	0.01	-1.393 (-9.787)	0.854 (3.107)	-0.539

t-ratios (from zero) at five per cent significance level in parentheses;
n.a.denotes restriction=zero (as t-ratios <±2);
I=intercept; N=cultivated Land; K=Tractors; F=Fertilisers; L=Labour; R=Rainfall;
NW=Northwest; NE=Northeast; SE=Southeast; SW=Southwest

[Source: Compiled by Author]

Appendix XI: Nature of Domestic Market Intervention and Trade Policies for Selected Agricultural Products in Poland. 1993-4.

Product	Policies	
	Domestic Measures	Trade Measures
Wheat	Intervention buying at predetermined prices	ad valorem tariff, occasionally adjusted de facto export subsidies
Coarse Grains	op cit. (rye)	op cit.
Oilseeds	/	ad valorem tariff, occasionally adjusted
Sugar	Intervention buying at predetermined prices	ad valorem tariff, minimum import price, export subsidies
Milk	guaranteed minimum price at farmgate level, intervention buying at predetermined prices of butter and skimmed milk powder	ad valorem tariffs for dairy products, import licensing of butter, minimum import price of butter and skimmed milk powder, de facto export subsidies (butter)
Beef	/	ad valorem tariff
Pork	occasionally intervention buying	ad valorem tariff, occasionally adjusted

[Source: Tangermann, Josling and Munch, 1994: 18]