# The Monetary Policy Transmission Mechanism and Inflation Control in Ghana.

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# Abstract

The central bank of Ghana officially adopted an explicit inflating targeting monetary policy in May 2007 following its operational independence in March 2002. This thesis firstly explores the evolution of monetary policy and inflation in Ghana, before characterising the conduct and effectiveness of monetary policy.

The thesis uses time series estimations of Taylor-type reactions functions to characterise monetary policy conduct and uses three other approaches to evaluate monetary policy effectiveness. In the first approach the long-run interest rate response to inflation, output gap, and other inflation precursors from estimated reaction functions is compared with Taylor's reference values. The second method analyses the responsiveness of the policy interest rate to commercial bank retail rates while the third approach investigates the monetary transmission mechanism to the wider economy using variables' impulse responses to investigate how other important variables that are either the final objective of policy or the conduit through which the final objective of policy is attained, behave in response to monetary policy. The analysis uses a modified cointegration and error correction model that is robust to the stationary properties of the data as well as vector autoregression techniques.

The results show monetary policy was largely effective in influencing the savings rate but not quite effective in controlling inflation. An alternative model (McCallum 1995a) that uses monetary aggregates as a policy instrument appears to explain monetary policy in Ghana better. The thesis suggests possible reasons for the non effectiveness of monetary policy and offer policy recommendations for long-term inflation control.

# Chapter 1

## 1.1 Introduction

Monetary policy has the major responsibility for curbing inflation and currency instability and also can ensure long-term economic growth. There is little agreement on what constitutes an optimal rate of inflation apart from stating that it should be low. However, there is growing acceptance among both policymakers and economists that the pursuit of price stability (defined as maintaining a low and stable rate of inflation) is the main medium- to long-run goal of monetary policy.

It is now almost universally acknowledged that inflation control is necessary for strong and sustained economic growth. A number of factors are responsible for this realisation. Prominent is the simultaneous experience of high inflation and decline in output growth by many countries from the 1970s to the early 1980s that brought to the fore the idea that even moderate levels of inflation damage real growth. While the literature points to varied sources of inflation, the agency responsible for its control is the central bank. To make central banks successful at discharging this responsibility, their hitherto diffused objectives have been focused, and price stability assigned primacy. This commitment of central banks to price stability has from the 1990s been shared by industrialised and developing countries alike. Similarly, the methods of monetary policy conduct have converged, with most countries adopting an explicit or implicit inflation targeting framework, implemented with market-oriented instruments. For countries in sub-Saharan Africa, this shift has occurred with varied intensity over the past two decades, usually as part of comprehensive reforms driven by the Bretton Woods institutions to liberalise the hitherto control-led approach to economic management.

One of the defining characteristics of the Ghanaian macro economy over the past 40 years has been its high, and often variable, rates of inflation[1]. Inflation was particularly high and variable in the politically turbulent 1970s and early 1980s, but has persisted throughout the gradual economic recovery since 1983. Though inflation

[1] Ghana is a small developing economy in sub-Saharan Africa with a population of 23.9million. A well-administered country by regional standards, Ghana, a multi-party democracy is often seen as a model for political and economic reform in Africa.

has been lower and less variable in the latter period, it still remains high in absolute terms and by comparison with Ghana's trading partners. High and variable inflation is typically seen as a symptom or indicator of macroeconomic instability. Monetary policy in Ghana is aimed at reducing inflation and improving international competitiveness. A framework of inflation targeting was introduced in March, 2002, following financial reforms which started in 1992.

The attainment of the price stability objective is to a large extent related to the efficiency with which monetary policy is implemented and policy impulses are transmitted to target and goal variables such as output and inflation. There has therefore been much interest in the last two decades, following the adoption of inflation targeting and price stability objectives by many countries, in investigating the effectiveness of monetary policy along the lines, one, from empirical estimations of interest rate setting by central banks and subsequent assessment of the stability properties of policy setting; and two, analysis of the ability of monetary policy to affect market interest rates and broader macroeconomic variables.

Friedman (1953, 1959) proposed the first definitive rule - a constant money growth rule-for monetary policy conduct. The rule stipulates that the money supply be increased by a constant per cent (k, equal to the expected growth of potential GDP minus the expected rate of increase of velocity) annually, and be independent of subsequent economic and financial considerations. Friedman argued that given the long and variable lags in the transmission of monetary policy, the constant money growth rule would avoid the instability of discretionary monetary policy and deliver low inflation. On the other side of the divide, the proponents of discretionary policy rejected definitive rules for what they do. They stressed the importance of policy adaptability as a means of keeping an uncertain environment under control. In their view, it is precisely because the economy is subject to uncertain shocks, and policies can have diverse effects, that discretion in policy implementation is desirable (Guitán, 1994).

However, Kydland and Prescott (1977, hereafter KP) and subsequently Barro and Gordon (1983, hereafter BG) changed the focus of the rules versus discretion argument. Using game-theoretic approaches, they demonstrated the superiority of rules over discretion for monetary policy conduct and put an end to the idea that a policy rule necessarily involves a fixed setting of the monetary authority's instrument variable. This literature has been the reference for many other arguments for rules for the conduct of monetary policy. The recommendation from this literature is that superior results in terms of social welfare are obtained if a government, through their central bank, follows a re-commitment device: notably, if they follow *a priori* rules. However, unlike the rule of the Friedman-type where there is no scope for ongoing policy-making (i.e. excluding discretionary policy-making), rules that have ensued from the KP and BG literature allow for on-going decisions.

However, the KP and BG solution of a rule to the inflation bias problem has been questioned, leading to alternative proposals. The alternative solutions have tended to rely on institutional arrangements that might leave the central bank free to pursue activist counter-cyclical stabilisation policies, while simultaneously inducing it to avoid the inflationary bias of discretionary monetary policy-making as identified by KP and BG. One such solution is reputation or credibility (e.g. Canzoneri, 1985; Rogoff (1985). For instance, Rogoff (1985) argues for the appointment of a central bank governor with much greater concern for price stability (relative to output) than society as a whole. Given that, the aggressive central banker proposed by Rogoff may reduce average inflation but at a cost of higher output variability. This line of research took the direction of examining the role of incentives contracts - e.g. Persson and Tabellini (1993) and Walsh (1995). Using the principal-agent framework, Walsh (1995) proposes a contract that directs the central banker to behave in a rule-like manner and not increase output variability. Blinder (1997), however, questions the approach because the principal (government) may not have the incentive to enforce the contract on the agent (central bank), being the time inconsistent government that necessitated the need for an incentive package in the first place.

Another institutional solution is granting central bank independence (CBI) - a logical solution, as an underlying assumption for the time inconsistency literature is the belief that the central bank is subject to undue political pressure. However, evidence on whether independent central banks can avoid inflation bias has been inconclusive. For example, significant dis-inflation amongst many developed countries was attained from the end of the 1970s to the 1980s without formal institutional changes (Friedman and Kuttner, 1996; Fuhrer, 1997a). Furthermore, empirical evidence also casts doubts on the robustness of the correlation between CBI indexes and inflation, real growth or unemployment. While Grilli *et al. (*1991), Alesina and Summers (1993), and Cukierman *et al. (*1993) find that improved inflation performance under CBI is not associated with slower growth; others like Fuhrer (1997a) and Campillo and Miron (1997), do not find such results. Moreover, even where favourable results (CBI vis-à-vis inflation and output growth) have been found, Fuhrer (1997a) observes that in general they hold only in the simplest bivariate cross-country regressions. Once other cross-sectional attributes are controlled for, the correlations disappear. In addition, for the favourable result, doubts have been raised with regards to causation (Leiderman and Svensson, 1995). The argument is that while evidence may reflect the causal effect of CBI on inflation, this could be the result of other factors that affect both inflation and output growth.

Considering the drawbacks of the institutional solutions, it appears that the dynamic inconsistency problem is best solved with monetary policy feedback rules, supplemented by institutional arrangements. Taylor (1993) draws on the findings of Bryant *et al.* (1993) and suggests a simple interest rate feedback rule that has a price anchor that successively mimicked US monetary policy during 1987-92. The subsequent findings that the Taylor (1993) rule satisfactorily explained other industrialised country interest rate settings has generated much interest in the rule, as argued by Woodford (2001) as follows: "The rule has since been subjected to considerable attention, both as an account of actual policy in the United States and elsewhere, and as a prescription of desirable policy".

Retail banks could react speedily or sluggishly to changes in policy interest rates; and international evidence from the empirical literature suggests some sluggishness in the response of commercial bank interest rates to changes in central bank policy interest and/or money market rates in the short run. In the long run, however, studies find higher pass-through.

Using error correction and VAR models, De Bondt (2002) examines the pass through from market to retail bank interest rates (deposit and lending rates) in the euro area.

Four main findings emerge from the study. First is the existence of cointegration between retail bank and market interest rates. Second, the lack of complete pass-through of market interest rates to retail bank interest rates in the short run: the highest pass-through in a month being 50 per cent. Third, is a higher pass-through in the long-run with the pass-through to lending rates reaching 100 per cent. Fourth is a faster interest rate pass-through since the introduction of the euro.

Sander and Kleimeier (2006) investigate the interest rate pass-through in the four Common Monetary Area (CMA) countries of the South African Customs Union (SACU). They employ an empirical pass-through model that allows for thresholds, asymmetric adjustment, and structural changes. They show that CMA bank lending markets exhibit a high degree of homogenisation as the pass-through is often fast and complete. Deposit markets are somewhat more heterogeneous, showing differing degrees of interest rate stickiness and asymmetric adjustment. Policy makers should therefore be concerned about imperfect competition which may be at the heart of the remaining cross-country differences in monetary transmission in the CMA. Such empirical work, despite the common approach to central banking now, has had only limited extension to developing countries.

This thesis aims to fill this gap by extending the body of empirical literature to Ghana.

Beyond the obvious extension of the literature that the thesis offers, the empirical estimation using Taylor-type reaction functions, vector autoregression and error correction models of monetary policy transmission has benefits for the country. It would help inform the extent to which monetary policy since policy reform has been purposeful, shifted monetary policy in the direction of genuine independence, and has provided a nominal anchor. The premise is that if the central bank has been consistent in policy making, then the policy instrument should systematically and significantly respond to important macroeconomic and target variables and the transmission of monetary policy shocks should be reasonably effective in influencing goal and target variables desired.

## 1.2 Inflation Overview

Inflation has been one of Ghana's major macroeconomic problems since the late 1960s, though the magnitude of this problem continues to vary over time. Immediately after independence, the rates of inflation were low and in the single digit range, averaging below 10% in the period 1957 – 1972. Although the rates were low, they were increasing gradually over time and in most cases beyond the rates achieved during the late 1950s. The period 1957–1972 marks the first inflationary episode in Ghana, typified by active involvement of the state in economic activity.

Inflation became a serious issue during the period 1973- 1982, the second inflation episode. This period was marked by several military interventions. Within this period, the various military leaders who came to power pursued expansionary economic management, which led to huge balance of payments deficits. The deficits that resulted were financed through expansionary monetary policy, which resulted in increases in money supply and, subsequently, effects on the economy through high general price levels. By 1983, inflation had reached a record high of 123 %.

When inflation was out of control and the entire economy was near collapse in 1983, the government adopted the economic recovery programme (ERP) proposed by the International Monetary Fund (IMF), with the aim of stabilising the economy. This marked the beginning of the third episode of inflation in Ghana. Though the ERP achieved some success in terms of reducing inflation rates and creating a degree of stability in the economy, the rates of inflation were still high compared with those achieved in the immediate period after independence.

Ghana still has not been able to achieve the single digit target level of inflation that it had achieved in the 1950s and early 1960s. Though various policies were adopted by successive governments to reduce the high and variable rates of inflation to a single and a relatively stable digit, there has not been any notable success.

The monetary policy setting in Ghana is typical of a small open developing economy. The context may be different, in terms of the structure of the policy framework including the government's overall economic strategy, the state of public finances and the financial system, but not so different to alter the monetary policy process in a fundamental way, however, the regulatory regime and the efficiency of markets have a bearing on the transmission of monetary policy actions through the economy.

The Bank of Ghana's primary objective (or mission) is "to pursue sound monetary and financial policies aimed at price stability so as to create an enabling macroeconomic environment for the promotion of sustainable economic growth". Various instruments have been used in an attempt to achieve this price stability goal even though inflation continues to be a hindrance to economic growth in the country. In the early 1980's for instance inflation rose to more than 100% with persistent GDP declines, which led to large fiscal deficits and overvalued exchange rate. There is therefore a need to determine the extent to which the Bank of Ghana (BOG) combats inflation with the traditional instruments of monetary policy such as the money supply and interest rates.

It is important to elaborate on three related underlying concepts - monetary policy objectives, monetary policy transmission mechanism and price stability, before expanding on the aims and contributions of the thesis and presenting the thesis outline.

## 1.3 Some Concepts

### 1.3.1 Monetary Policy Objectives

Monetary policy objectives are similar across different countries. This comprises the rules and actions adopted by central banks to achieve their objectives. The objectives of monetary policy include: stable foreign exchange rates, equilibrium in the balance of payments, stable financial system, increased capital investments, price stability, enhanced economic growth, and ultimately, the improved welfare of citizens (Poole, 1999; Friedman, 2000b; Bofinger, 2001). However, the dominant trend in the theory and practice of monetary policy over the last two decades has been its dedication to price stability (Tobin, 1998; King, 1999), with the supremacy of this objective prescribed in some national constitutions and central bank laws (Bofinger, 2001).

### 1.3.2 Transmission Mechanism

The channel by which monetary policy is transmitted to the real economy is a central topic of debate in macroeconomics. It is also difficult to disentangle causes and effects of monetary policy on the inflation and real activity from their influences.

These notwithstanding, monetary policy authorities need to make an effort to estimate the transmission mechanism in order to have an idea of how long it takes for their policy actions to impact on key macroeconomic variables and by what magnitude. For monetary policy to be effective in achieving its intended goals, it requires the existence of a stable and predictable mechanism through which the central bank's purely financial actions are transmitted to non-financial decisions of household and firms, i.e. the existence of an effective monetary transmission mechanism. This suggests that a useful way to analyse monetary policy is to focus separately on central bank policy actions (via monetary policy rules), and the mechanisms through which the actions take their effect (the monetary transmission mechanism). This is the approach to empirical analysis this thesis adopts.

### 1.3.3 Price Stability

There are some differences in the way central banks conduct their monetary policies, but one thing is common across almost all central banks are the objectives of monetary policy. The objectives of monetary policy are usually stated as price stability or to keep inflation low and stable. Alan Greenspan (1996) defines price stability, the overriding objective of monetary policy, as the rate of inflation that is sufficiently low that it does not affect economic behaviour of businesses and households. To put it simply: low and stable inflation. However, the literature, e.g. Fisher (1996), points to a subtle but important difference between inflation as a target on the one hand and price stability on the other. With an inflation target, the central bank is not required to compensate for failures in achieving its target in previous periods. If the target is the price level, however, the central bank has to attempt to compensate for missing the target in previous periods (Fisher, 1996; Bofinger, 2001). Fisher argues that, over the long term, price level targeting produces more certainty about prices than does inflation targeting, but this is at the cost of more short-run variability in inflation. Additionally, price level targeting is associated with risks because of limited knowledge of the short-run monetary transmission process (Bofinger, 2001).

Both policymakers and academics generally accept price stability to mean low and stable inflation which leads to the consideration of that level of inflation that quantifies stable prices. Levels that have been proposed include a zero rate of inflation (Feldstein, 1997), a rate between 2 and 3 percent (Summers, 1991), and a rate between 3 to 4 per cent (Krugman, 1996). Whilst Feldstein argues that a zero rate of inflation implies a higher welfare than a low level of inflation, the consensus is for a level between 1 and 3 per cent for low-inflation countries (Fischer, 1996; Bernanke and Mishkin, 1997). Three principal reasons advanced as support for this inflation range are the scope for real interest rates to be negative, the leeway for reductions in real wages, and the accommodation of upward bias in measured inflation. Revenue motives have also been given as a reason; however, this is unlikely to justify significant rates of inflation. For instance, in the United States, where the monetary base is 6 per cent of GDP, an extra 1 per cent of inflation would generate less than 0.05 per cent of GDP in revenue. Regarding the scope for negative real interest rates, the argument is that since nominal interest rates are bounded at zero, a small but positive rate of inflation permits real interest rates to become negative, enabling stimulation of aggregate demand in the face of contractionary shocks (Summers, 1991; Fisher, 1996; Mankiw, 2001). The argument here is that inflation greases the wheels of monetary policy. The serious constraints placed on

monetary policy in a zero inflation or deflationary environment have recently been evident in Japan. They constitute an important reason to target a low positive rate of inflation rather than zero.
With respect to the latitude for reductions in real wages, the argument is that as firms are reluctant to cut workers' nominal wages and workers reluctant to accept such cuts, a positive rate of inflation enables a reduction in real wages. This facilitates relative real wage adjustments to reflect productivity differentials, enabling better functioning of the labour market that helps to stimulate an economy in recession (Tobin, 1972; Fisher, 1996; Mankiw, 2001). Another important reason is the upward bias in measured inflation. This stems largely from improvements in the quality of existing goods and from delays in introducing new goods in the basket (Fisher, 1996; King, 1999; Lewis and Mizen, 2000; Clarida et al., 1999). The bias is estimated to be between 0.5 and 2 per cent, necessitating a small but positive inflation (about 2 per cent) to account for it. The impact of this bias on the optimal target rate of inflation is not self-evident if money illusion matters for real resource allocation. It is clear though that if the bias is understood in the capital markets, then the need to keep open the possibility of negative real interest rates would argue for a higher target rate of inflation.

These arguments point to a target inflation rate in the 1-3 per cent range; more specifically, they suggest that inflation should be targeted at about 2 per cent, to stay within a range of 1-3 per cent per year. This, in practice, is what most central banks mean by price stability; it is also a target that most G-7 central banks have already attained.

While the reasons outlined underpin the 1-3 per cent inflation range that would be a reasonable approximation for price stability for low-inflation countries, for emerging and developing economies, the inflation rate that would be synonymous with price stability can be argued to be slightly higher for reasons including (i) the Balassa-Samuelson effect (Mishkin and Schmidt-Hebbel, 2001), (ii) larger biases due to higher levels of omissions in the compilation of the consumer price index because of a relatively faster introduction of new products and larger improvements in the quality of goods (Skreb, 1998), (iii) inflation inertia arising from indexation due to past inflation, and (iv) the inherent adjustment costs associated with a transition to a more efficient market economy. This thesis proposes a 2-5 per cent inflation target range to symbolise price stability in emerging and developing countries. The analysis leading to this proposal is presented in Chapter 5.

It is necessary to specify a range because the inflation rate is not precisely controllable. The width of the target band would vary across economies depending on their structure, especially the variance of the exogenous shocks that hit the economy. The lower bound would be taken as seriously as the upper bound.

## 1.4 Aims and Contributions

This thesis has several aims. First, it seeks to contribute to the empirical literature on monetary policy (monetary policy reaction functions, responsiveness of output and inflation to changes in policy interest rates, and to the broader literature on the monetary transmission mechanism and the importance of the credit channel); it also contributes to the literature and policy advice on inflation control in general and specifically for developing countries.

High inflation became a major policy concern in the period under consideration. Thus this study hopes to provide important results geared directly towards improving the monetary stance and inflationary structure of the Ghanaian economy.

To achieve these aims, the thesis estimates Taylor-type reaction functions to derive the best characterisation of monetary policy for the sample period considered. Policy effectiveness is then inferred by comparing long-run interest rate responses to the variables with theoretical specifications for sustainable inflation control. The complementary assessment of monetary policy effectiveness uses two other approaches. One is by analysing the responsiveness of commercial bank interest rates to changes in the policy interest rate; the other is by estimating the fuller monetary transmission and assessing the degree to which they facilitate the attainment of monetary policy goals and target.

This empirical research is motivated by the fundamental role of monetary policy for macroeconomic stability, particularly price stability, and its subsequent implication for economic growth. The weight of evidence in the literature is that low inflation countries experience higher growth rates (e.g. Kormendi and Meguire, 1985; Fisher, 1993; De Gregorio, 1993), a finding that makes it imperative for monetary authorities to achieve their price stability objective.

## 1.5 Organisation of the Chapters

This thesis is in eight chapters. Chapter one serves as an introduction and chapter two provides an overview of macroeconomic and financial sector developments in sub-Saharan Africa. Chapter three provides an overview of Ghana's macroeconomic and financial sector development. The chapter highlights the country's economic progress with reference to the institutional and economic structural characteristics following the economic recovery programme and financial sector reforms which started in 1983. It also provides a survey of some empirical studies undertaken on the monetary transmission mechanism.

As the theoretical basis of the thesis, chapter four is in two parts; the first part deals with the general economic framework for inflation in an open economy and the second part of the chapter contains a theoretical framework for the particular case of inflation analysis in Ghana. Chapter five summarises the econometric methodology and estimates the monetary policy reaction functions.

In Chapter six, the responsiveness of commercial bank retail rates to policy interest rates, the equilibrium correction methodology and vector autoregression analysis are undertaken. It assesses the country's monetary policy effectiveness by evaluating the responsiveness of the commercial bank retail rates to changes in the policy interest rate. While informative, it can be argued that its usefulness is limited because of its focus only on the initial phase of the transmission process. A fuller assessment of monetary policy effectiveness, by the transmission mechanism approach, would require an investigation into how other important variables that are either the final objective of policy or the conduit through which the final objective of policy is attained behave in response to monetary policy impulses. This fuller assessment is the main objective of Chapter seven.

In meeting the objective in chapter seven, the chapter also provides information that holds promise to facilitating the design and implementation of monetary policy itself. In particular, it provides a view on the optimal timing of policy actions. Furthermore, the chapter cross-references the results it finds with those from the single equation models of, first, the monetary policy reaction functions of Chapter five and second, the responsiveness of the commercial bank retail rates to the policy interest rate analysis of Chapter six. A key assumption underlying the estimations in Chapters five and six is that the information variable(s) are weakly exogenous. Chapter seven, which relaxes this assumption by recognising the simultaneity amongst the variables, should offer a means of establishing the robustness or otherwise of the results earlier found. Chapter eight, ends the thesis with the research conclusions, policy recommendations, and suggests areas for future research.

# Chapter 2

# Macroeconomic and Financial Sector Developments in sub-Saharan Africa

## 2.1 Introduction

This section has two objectives. First, it aims to provide some distinguishing features of sub-Saharan African (SSA) economies that may affect their monetary management and the transmission mechanism. Secondly, it seeks to justify the choice of Ghana as the most representative of SSA economies, through a review of macroeconomic developments and the evolution of financial sectors of SSA economies.

## 2.2 Brief Overview

An overview of economic development in SSA shows that, whilst most SSA countries have turned to market-based instruments of monetary management, many have under-developed systems. The literature on the macroeconomics of countries in the SSA indicates that many SSA economies grew appreciably after independence until the 1970s, when their growth stagnated or declined (e.g. Calamitsis, 1999). The principal factor responsible was the inward-looking and high-state-intervention development strategy that the countries adopted post independence. Policymakers adopted the view that it was possible to foster economic growth by identifying growth promoting sectors and providing subsidised credit to promote those sectors. Governments also controlled interest rates, which, in the context of high and volatile inflation, often resulted in negative real interest rates.

To jumpstart their economies and return them to a positive growth path, many countries initiated reform programmes during the first half of the 1980s. In particular, they adopted stabilisation and structural adjustment programmes that comprised macroeconomic (fiscal, monetary, and exchange rate policies), structural (trade, tax, and sectoral policies), and social inclusion policies that had the support of the IMF and the World Bank (Tarp, 1983).

Some countries (a good example being Ghana) witnessed improvements in their economic performance, evidenced by increasing growth rates, declining inflation, and narrowing financial imbalances following the reforms (Mehran et al., 1998; Calamitsis, 1999). Despite these improvements, SSA is still beset with features that distinguish it from industrialised countries. These features include higher levels of openness, exogenous terms of trade, higher fiscal deficits, higher levels of inflation, and larger informal sectors.

### 2.2.1 Background of SSA Economies

The region's annual trade as a proportion of GDP averaged 54.4 per cent over the period 1970-2000, and 57.8 per cent over 1990-2000. The comparative statistic for the USA, whose monetary policy is arguably the most studied, is 18.1 per cent over 1970-2000 and 23.3 percent during 1990-2000. SSA is more open to trade in goods and services than the major industrialised countries.[2] Further, while SSA's exports are largely agricultural, its imports are dominated by intermediate goods, accounting for up to 70 per cent of total imports. The region also faces exogenous terms of trade (Agenór and Montiel, 1999) and volatility in exchange rates sometimes resulting from shifts unconnected with the country itself, an example being the recent substantial adjustment of the US dollar and the euro and their associated impact on domestic monetary conditions. These suggest that trends in the exchange rate are more likely to be important for the stability of countries in this region than for industrialised economies.

Saxegaard (2006) examines the pattern of excess liquidity in sub-Saharan Africa and its consequences for the effectiveness of monetary policy. He argues that understanding the consequences of excess liquidity requires quantifying the extent to which commercial bank holdings of excess liquidity exceed the levels required for precautionary purposes. His paper proposes a methodology for measuring this quantity and uses it to estimate a nonlinear structural VAR model for the CEMAC region, Nigeria and Uganda.[3] The study suggests that excess liquidity weakens the

[2] Openness is measured as imports and exports of gross domestic product.

[3] The Economic and Monetary Community of Central Africa (or CEMAC from its name in French, Communauté Économique et Monétaire de l'Afrique Centrale) is an organisation of states of Central Africa established by Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea and

monetary policy transmission mechanism and thus the ability of monetary authorities to influence demand conditions in the economy.

Agenór and Montiel (1999) indicate that in this region, the informal urban sector can account for up to 60 per cent of total employment and economic activity, compared to its virtual non-existence in industrialised countries. The informal sector plays a significant role in employment and economic activity in SSA (Agenór and Montiel, 1999; Plenderleith, 2003). In addition, countries in SSA continue to depend on the agricultural sector for growth and employment.

SSA countries have systematically suffered from bad fiscal policies that have exacerbated the effects of external shocks, resulting in chronically high fiscal deficits. At reasonable levels, fiscal deficits have minimal adverse effects on the financial system. But when fiscal deficits are chronically high, this increases the likelihood of monetary financing of the deficits and also forces the government to compete with private actors in the credit market. However, fiscal imbalances generally tend to be more pronounced in developing countries than in industrialised countries. Over the period 1990-2000, while the fiscal deficit to GDP ratio averaged 1.9 per cent per annum in industrialised countries, the equivalent was 3.2 per cent in SSA. In addition, the financing of the deficit in SSA has tended to be more inflationary, through central bank accommodation. It therefore comes as no surprise that inflation is higher in developing countries than in industrialised countries. For example during the period 1989-98, annual inflation averaged 3.1 per cent in industrialised countries; but averaged 33.2 per cent in developing countries.

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Gabon to promote economic integration among countries that share a common currency, the CFA franc.

### 2.2.2 The Financial Sector of SSA Economies

Generally SSA financial sectors all began with the establishment of colonial banks dedicated to offering banking services to colonial enterprises. These banks together with the monetary authorities formed the financial system in most countries until independence.

In the early post-independence era, African governments sought to use financial development as a tool of speeding up economic growth. Governments became the main players in the creation of new financial intermediaries. With the aim of addressing the perceived lack of national developmental objectives on the part of the colonial banks, many countries nationalised these banks upon independence. In addition, new state-owned banks were established to principally finance industry and government budgets and also to penetrate the rural economy through aggressive branching. The banks soon began to show signs of mismanagement, reflected by high non-performing assets. The financial system was characterised by pervasive default on loans, especially by state-owned enterprises, which accounted for a large share of domestic credit supply. This weakened financial intermediaries, forcing governments to inject more resources in the system in the form of subsidies to keep ailing institutions afloat. This, as well as the use of instruments of direct control for monetary management and poor banking supervision, meant that by the mid-1980's the financial sector in most SSA countries had become weak and vulnerable, reflecting features of repression.

By the mid-1980's, the financial sector in these countries was experiencing the same problems of mismanagement and inefficient allocation of resources that plagued the public sector in the majority of African countries. The degeneration of the financial system prompted many countries to embark on reforms from the mid 1980s, towards an efficient and market-oriented financial sector that would contribute effectively to economic development. Key components of the reforms included: interest rate liberalisation, elimination of credit controls, restructuring and privatisation of banks, strengthening of financial infrastructure (including bank supervision, accounting, and auditing practices), and engendering competition in the sector.

Since embarking on financial sector reforms, following the trend in advanced economies, price stability has tended to be the overriding objective of monetary policy in many SSA countries, with the accepted view that long-run growth is best promoted through the maintenance of low inflation (Honohan and O'Connell, 1997). In addition, the autonomy of central banks in this region has increased and monetary policy conducted with indirect instruments. The indirect instruments employed, in line with the practice in advanced economies, are: the bank rediscount rate, lending facilities, open market operations (OMO), repurchase agreements, and variable reserve requirements. A supplementary tool in some cases has been moral suasion, by which the central bank tries to retrain credit growth indirectly.

### 2.2.3 The Role of the Central Bank

Financial systems development in African countries will necessitate the ability of central banks to exercise efficiently their functions to promote the stability of the financial system and the macroeconomy. To achieve this goal, central banks need to be endowed with an adequate level of autonomy.[4] In principle, central bank independence serves as a restraint on government policy, especially by shielding monetary policy from fiscal indiscipline through specific rules governing government borrowing from the central bank. This enables the central bank to exercise discretionary monetary policy rather than simply accommodating fiscal indiscipline by the government. Central bank independence also plays an important role in establishing credibility for monetary policy, which is a key ingredient for the stability of the macroeconomy. Credibility of the central bank facilitates decision-making by private actors by reducing the uncertainty of the policy environment.

[4] Central bank independence generally means "instrument independence", which is the ability of the central bank to choose the tools in order to pursue specific ultimate goals mandated by the legislature. To assess the degree of central bank independence, researchers combine information on both the (formal) legal institutional prescriptions and actual practice. Such information includes: the rules of appointment and dismissal of the governor; the legal mandate of the bank to pursue price stability (and how important this objective is relative to others); the rules and limitations on government borrowing from the central bank; the length of the term in office and turnover rate of central bank governors. Seminal works on indicators of central bank independence and the relationship between these indicators and outcomes of monetary policy include Grilli, Masciandro, and Tabellini (1991), Cukierman (1992), Alesina and Summers (1993), and Agbeja (2007) whose work is on sub-Saharan Africa.

Central banks in SSA have not performed well in their function as a restraint on government policy and they have performed poorly also in their role as a regulator of the banking sector. Until recently, most countries lacked the basic laws that govern the regulatory functions of the central bank; and even when the laws existed, they were poorly enforced. This is true for national banks as well as supranational banks as in the case of the CFA zone, for instance. We highlight three main reasons for these weaknesses.[5]

First, national authorities have regarded the central bank as their primary financier, and have therefore been reluctant to relinquish their political leverage over monetary policy for the purpose of deficit financing. This illustrates the short-termism that characterises political calculations on the part of national leaders.

The second factor is the poor institutional design of central banks starting from their creation. For example, while countries have rules on limits for government borrowing from the central bank, they rarely have statutory provisions for conditionality and sanctions in the event that those rules are violated.[6] Moreover, the leadership of central banks (national and regional) is generally not independent of the executive branch of government. Governors of national central banks in sub-Saharan Africa (with few exceptions, like South Africa) usually have little or no independence from the government. This is also the case for the regional central banks in the CFA zone. For instance, the members of the boards of the two regional central banks of the CFA zone are representatives of Finance Ministries of member countries and include no representatives from commercial banks. Recently, many countries have made significant advances in this area with the establishment or strengthening of banking laws to provide more independence to the central bank and a stronger prudential regulation base (Aryeetey and Senbet, 2000).

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[5] Other constraints include the lack of qualified central bank staff in the areas of supervision and regulation and the slow pace of adjustment of the regulatory framework to changes in the scale and scope of financial market operations (see Aryeetey and Senbet, 2000).

[6] For example, most CFA member governments systematically exceeded their borrowing ceilings (by as much as 80% for the government of Côte d'Ivoire). Also governments were able to circumvent the limits by indirect borrowing via state-owned enterprises or by pushing commercial and development banks to supply credit to relieve fiscal pressures (Stasavage, 2000)

The third factor is the lack of a strong private financial sector lobby (Stasavage, 2000). An active private financial sector lobby is an important factor in fostering central bank independence especially when the formal institutional foundation is weak or non-existent. The private financial sector has an advantage in central bank independence because it is a means to achieving greater price stability. Due to the inherent maturity mismatches between the assets and the liabilities of financial institutions, inflation volatility is highly costly for these institutions.

The willingness of politicians to grant central bank independence depends on whether the perceived problem (or political liability) is price instability or low growth. If it is the former, governments are likely to be more inclined to relinquish control over monetary policy, whereas if it is the latter, politicians may sacrifice monetary policy autonomy to the short-run benefits of expansionary monetary policy. In the long run, however, countries benefit from the macroeconomic stability that arises from monetary policy autonomy.

There are also alternative arrangements that can be used to restrain monetary policy. Examples include the adherence to a fixed exchange rate regime and membership of a monetary union. However, just as with the case of central bank independence[7], these alternative arrangements are effective only if there are clear rules that prevent countries from failing to fulfill their obligations.

### 2.2.4 The Financial Sector after Reforms

SSA countries share trends as a group; however, they also have had diverse financial and monetary experiences and are now at different stages of financial sector development (Honohan and O'Connell, 1997). Some countries have progressed faster and further, whilst others have yet to make significant headway with reforms.

Mehran et al. (1998) in their reviews of the financial sectors of some 32 SSA countries find that overall all 32 countries have since their political independence

[7] The conventional assumption is that central bankers are more conservative (have a stronger tolerance level for the costs associated with achieving low inflation) than the society as a whole (Rogoff 1995). This motivates the emphasis on central bank independence as a means to achieving price stability.

developed their financial sectors. The monetary authorities have become more effective in the control of monetary aggregates[8]. The structure of the financial systems has also improved, with government ownership of banks reduced. Of the key areas of the financial sector considered, research finds that countries have made the most progress in domestic monetary operations, i.e., in establishing market-based monetary policy instruments and procedures[9]. The 32 countries, with the exception of only three (Angola, Ethiopia, and Lesotho), were found to have fully liberalised interest rate and credit policies, and relied on some form of OMO. Interbank operations and secondary market activities in many countries were, however, found to be quite embryonic. The two most advanced countries were South Africa and Kenya. These two countries were indicated to have well-developed secondary markets for government securities and active modern financial sectors that facilitate open market operations. The next best performers were Ghana, Uganda, Tanzania, and Zimbabwe.

Mehran et al. (1998) use a composite of five indicators to gauge the autonomy of the central banks of the countries and conclude that most SSA countries recognise the importance of providing a favourable legal and regulatory framework for the efficient conduct of monetary policy and ultimately for the attainment of the price stability objective[10]. The most autonomous central banks were deemed to be South

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[8] For example, net claims on government as a proportion of GDP fell while claims on the private sector rose.

[9] The five key areas of the financial sector considered are: domestic monetary operations, external sector liberalisation, strengthening of banking supervision, central bank autonomy, and payments system.

[10] The first indicator for autonomy is the predominance of price stability as the primary objective of monetary policy. The second is the extent to which the central bank Governor has authority to implement policy without reference to government. The third is the extent to which the Governor and other members of the bank's governing body are isolated from short-run political influence. The fourth is the extent to which the banks have economic autonomy and the fifth, the extent to which accountability through prudent reporting is provided for. Using the first indicator, Mehran et al. (1998) find that all 32 countries have price, currency or monetary stability as an objective. However, only five countries, Kenya and South Africa included, have price stability as the explicit primary objective. Regarding the second indicator of autonomy - the extent to which the central bank was given sufficient authority to implement monetary policy - the authors find that about half of the sample (South Africa, Kenya, Ghana, and Uganda included) had this authority by way of, for example, the central bank governor having terms that exceed the political business cycle. In addition, six countries (Kenya, South Africa, and Uganda included) have transparent means of co-ordination and conflict resolution, further guaranteeing autonomy. For the fourth indicator economic autonomy, it was found that all central banks with the exception of South Africa have provisions that explicitly limit direct credit to government. For the last indicator - accountability - most central banks were found to have at least the minimum level in place with some, including Kenya, requiring the central bank to present semi-annual reports.

Africa, Kenya, and Madagascar. Ghana and Uganda were found to have performed satisfactorily on this criterion as well.

With regard to the financial market stability objective, these authors find that all the 32 central banks seek to ensure a safe and efficient financial system. The authors also find that a large number of countries have made considerable progress in banking supervision, in line with the Basle Committee's Core Principles. Furthermore, the payment system has improved and most countries have moved from pegged to floating exchange rate regimes. All areas considered, Mehran et al. (1998) find South Africa and Kenya to have the most advanced financial sectors, with Ghana, Uganda, Tanzania, Zambia, Zimbabwe, and Mauritius as the next best performers.

Gelbard and Leite (1999) also investigate financial sector development in 38 African countries over the period 1987-97 using a set of six indices[11]. Categorising the countries into four (largely-developed, somewhat-developed, minimally-developed, and underdeveloped) based on the six indices, Gelbard and Leite (1999) find that countries made significant progress in improving and modernising their financial systems over the period. The number of countries classified as having "somewhat" or "largely" developed financial systems increased from two countries (South Africa and Mauritius) in 1987 to 27 (including Ghana - largely developed; and Kenya and Uganda - somewhat developed) in 1997. At the same time, the number of countries with totally undeveloped financial systems declined from eight in 1987 to two (Angola and Ethiopia) in 1997. Overall, they find six countries with the most developed financial systems in 1997. These are South Africa, Mauritius, Ghana, Kenya, Zambia and Namibia.

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[11] The indices comprised: market structure, availability of financial products, stage of financial liberalisation, institutional environment under which the financial system operates, the degree of integration with foreign financial markets, and the sophistication of policy instruments.

## 2.3 Summary

The evidence discussed in this chapter indicates that financial systems are still relatively underdeveloped in many countries in SSA. However, recent structural and institutional indicators of financial sector development paint a relatively more optimistic picture. These indicators show that a number of countries have made significant progress in promoting an environment that is conducive to financial intermediation. This is typically the case for countries that have consistently pursued macroeconomic reforms, especially through fiscal discipline, which has promoted a stable business environment. Much progress is still needed, however, especially to strengthen the institutional framework for banking regulation, promote monetary policy autonomy, establish government and central bank credibility, develop banking supervision capacity (through investment in technology and human capital), which will create an environment that is conducive to investment and saving. Progress in those areas will not only promote financial market development but will also foster economic growth.

The literature on the financial sector and monetary management in SSA have tended to rank South Africa, Kenya, and Ghana amongst the best performing countries in the region, with South Africa and Kenya found to have the most developed financial sector and system of monetary management. Of these countries, the financial sector and system of monetary management in Ghana is more representative of SSA as a whole than those of Kenya and South Africa; hence, its study may serve a broader purpose in providing a general understanding of the monetary policy transmission mechanism in SSA.

The evolution of the financial sector in Ghana is discussed in Chapter 3 to provide a perspective for the assessment of monetary policy in the country. The Chapter briefly examines some of the country’s macroeconomic and financial sector policies.

# Chapter 3

# Ghana’s Macroeconomic and Financial Sector Development Overview

## 3.1 Introduction

In this chapter, an overview of Ghana’s macroeconomic and economic development is presented, in order to provide a context and perspective for the assessment undertaken in the remainder of this study. This chapter highlights the country’s economic performance and inflation movements from independence in 1957 to 1983 and through to 2006. It makes broad reference to the institutional and economic structural characteristics following the economic recovery programme and financial sector reforms which started in 1983.

The year 1992 is used as the starting year in this thesis. A number of reasons led to this choice: following the introduction of the economic recovery programme (ERP) in 1983, there was more privatisation of state owned companies and the economy moved towards a free market and a free market oriented monetary policy. Policy reforms towards the attainment of the objectives of the ERP and structural adjustment programme (SAP) included the pursuit of: exchange rate and trade liberalisation, growth-oriented and deficit-reducing fiscal policy characterised by a reduction in recourse to bank financing, restrictive monetary policy, and structural and institutional reforms. Special emphasis was placed on pursing a flexible exchange rate policy, given the pressing need to improve resource allocation (Kapur et al., 1991). The liberalisation of the exchange rate began in April 1983, and was completed in April 1992 with the full operation of a truly market-determined exchange rate (Sowa and Acquaye, 1999).

By 1992, interest rates and credit had been decontrolled and institutional arrangements to facilitate the system of indirect monetary management put in place. The system of indirect monetary management began in that year.

## 3.2 A Brief Macroeconomic Overview

Agriculture accounts for the bulk of the country's workforce, output, and export revenue. Cocoa and gold have historically been and still are the country's lead exports.

Ghana at independence in 1957 had a per capita income that put it on a par with some now newly industrialised countries like South Korea and Malaysia, the so called Asia tigers, and was more favourably placed to develop than most countries in sub-Saharan Africa. Factors favourable to the country included: its position as the world's leading producer and exporter of cocoa, exporter of 10 per cent of the world's gold, with three years of import cover in foreign exchange reserves, and with one of the best infrastructure systems and educated populations in Africa (Konadu-Adjemang, 2001).

After independence, Ghana adopted a centrally-controlled development strategy. Some specific policies pursued included import-substituting industrialisation (ISI) and controls of prices (including of the exchange rate), external trade, and the financial sector. The heavy government intervention together with a fall in world price of cocoa in the mid-1960s adversely affected the country's economic health. From respective levels of US$269 million and 4 per cent in 1957, by 1966 national foreign exchange reserve had fallen to –US$391 million and GDP growth dwindled to -4.3 per cent. The economic deterioration led to brief attempts at stabilisation in 1967 and 1971 with loans and technical assistance from the IMF. However, in 1971, Ghana returned to its earlier policies. In particular, the country emphasised expansionary fiscal policies financed by monetary accommodation, price controls, and restrictive foreign exchange policies and external trade. These policies distorted relative prices, put upward pressure on prices, and stagnated the economy. By 1983, in combination with severe external shocks, the economy had contracted dramatically: GDP growth fell to -4.6 per cent and inflation peaked at 122.9 per cent. The collapse of the economy prompted the government to adopt an IMF and World Bank supported Economic Recovery Programme (ERP) from mid-1983 to 1986 and its follow-up, the Structural Adjustment Programme (SAP), which had financial sector reforms as a component, over 1986-91.

Kapur et al. (1991) outlined the key objectives of the ERP as (i) a realignment of relative prices, (ii) a progressive shift away from direct controls and intervention towards greater reliance on market forces, (iii) fiscal and monetary discipline, (iv) the rehabilitation of economic and social infrastructure, and (v) increased productivity and efficiency of the economy. While having the same objectives, the SAP was directed more at addressing deep-seated structural bottlenecks to economic recovery. Policy reforms towards the attainment of the objectives of the ERP and SAP included the pursuance of: exchange rate and trade liberalisation, growth-oriented and deficit-reducing fiscal policy characterised by a reduction in recourse to bank financing, restrictive monetary policy, and structural and institutional reforms. Special emphasis was placed on pursuing a flexible exchange rate policy given the pressing need to improve resource allocation (Kapur et al., 1991). The liberalisation of the exchange rate began in April 1983, and was completed in April 1992 with the full operation of a truly market determined exchange rate (Sowa and Acquaye, 1999).

Leechor, 1994; and Kapur et al., 1991 among others have judged the economic reforms over 1983-1991 as a success, with the more remarkable aspect being the re-orientation of the economy on market principles, fiscal discipline, GDP growth, and inflation control. Revenue mobilisation improved from 4.6 per cent of GDP in 1983 to 13.2 per cent in 1991, enabling government to spend as needed while at the same time generating budget surpluses. From a deficit of 2.7 per cent of GDP in 1983, the budget balance improved to a surplus of 0.1 in 1986 and further to a surplus of 1.6 per cent of GDP in 1991. Inflation moderated to 28.3 per cent during 1984-1991 (from an annual average of 76.5 per cent during 1976-1983) and real GDP growth average of 5.4 per cent over the same period.

In 1992 the country had its first democratic elections in over a decade. Under democratic rule, the country's economic policy orientation remained directed at macroeconomic stabilisation and structural reforms. However, the overall economic outcome during 1992-2000 was not one of distinct progress as it was in the 1983-1991 period. Inflation was more erratic (oscillating between 59.5 per cent and 10 per cent) and the budget deteriorated (with deficits in six of the nine years, reaching 8.6 per cent in 1992). GDP growth, however, remained steady at about 4.2 per cent annually.

## 3.3 The Economic Recovery Programme

The government launched the Economic Recovery Programme (ERP) in 1983 under the guidance of the World Bank and the IMF. The overriding purpose of the ERP was to reduce Ghana's debts and to improve its trading position in the global economy. The stated objectives of the programme focused on restoring economic productivity at minimum cost to the government and included the following policies: lowering inflation through stringent fiscal, monetary, and trade policies; increasing the flow of foreign exchange into Ghana and directing it to priority sectors; restructuring the country's economic institutions; restoring production incentives; rehabilitating infrastructure to enhance conditions for the production and export of goods; and, finally, increasing the availability of essential consumer goods. In short, the government hoped to create an economic climate conducive to the generation of capital.

The ERP was carried out in roughly three phases. Beginning in 1983, the government focused on reducing its expenditures while creating incentives for private production. Initial expenditure cuts and improved tax collection brought the budget deficit down from 6.3 percent of GDP in 1982 to 0.1 percent by 1986, relieving government pressure on the banking system, while a series of cedi devaluations boosted export activity. During the second phase, which lasted from 1987 to 1989, the government moved to divest itself of many assets through privatisation and to institute radical foreign exchange reforms to devalue the cedi further. Although privatisation was sluggish, the hard-currency black market was nearly eliminated with the introduction of foreign exchange bureaus in 1988. In the ERP's third phase, the government intensified monetary reforms and reduced private corporate taxes to boost private-sector growth.

By the end of 1991, ERP efforts had improved the country's international financial reputation because of its ability to make loan repayments (although not wipe out foreign debt) and its first entry onto the international capital market in almost two decades. Critics maintained, however, that the ERP had failed to bring about a fundamental transformation of the economy, which still relied on income earned from cocoa and other agricultural commodities. Critics also contended that many Ghanaians had seen few, if any, benefits from the programme.

In addition to its focus on stabilising the country's financial structure, the ERP also aimed to promote production, especially in the export sectors. In 1986 the government began to rebuild infrastructure through a US$4.2 billion programme, more than half of which was provided by external sources. This amount was divided roughly equally among infrastructure repair, energy imports (oil for machinery), and export industries. Increased imports financed by the IMF, the World Bank, and other sources made possible the rehabilitation and repair of some key parts of the infrastructure through the supply of spare parts and inputs for industry, mining, utilities, and agriculture.

Although the ERP was geared primarily towards restoring the country's international economic standing, it came under popular criticism inside Ghana for ignoring the plight of those not involved in the export sector. The overwhelming shift in resources was toward cocoa rehabilitation and other export sectors, not towards food production. Government employees, especially those in state enterprises, were actively targeted, and many lost their jobs. Farmers suffered as the percentage of the total budget devoted to agriculture fell from 10 per cent in 1983 to 4.2 per cent in 1986 and to 3.5 percent in 1988, excluding foreign aid projects. Although cocoa contributed less to Ghana's GDP than food crops, cocoa nonetheless received 9 per cent of capital expenditures in the late 1980s; at the same time it received roughly 67 per cent of recurrent agricultural expenditures because of its export value.

The government, in response to criticism of its policies, initiated the US$85 million Programme of Action to Mitigate the Social Costs of Adjustment (PAMSCAD). Beginning in 1988, the programme sought to create 40,000 jobs over a two-year period. It was aimed at the poorest individuals, small-scale miners and artisans in particular, and communities were to be helped to implement labour intensive self-help projects.

In the early 1990s, the government was committed to continuing the policies of the ERP. New agreements were concluded with the World Bank to continue credit arrangements on condition that Ghana review and revise its various economic laws and regulations and support private sector development. In particular, the government agreed to revise or to repeal existing laws and regulations affecting private investment that undermine the spirit of deregulation, economic liberalisation, and exchange rate reforms. The government also agreed to develop and to strengthen the institutional framework that would facilitate private investment. Key priorities for 1992 and beyond included giving new impetus to state enterprise reforms, broadening the scope of banking-sector reforms, liberalising the administrative framework, and strengthening public-sector management. Basic education and primary health-care services were to receive attention over the long term as well. (US Library of Congress http:/countrystudies.us/Ghana/65.htm 03/08/2007)

## 3.4 Macroeconomy and Inflation

This section is in two parts. The first part reviews the macroeconomy and inflation before the Economic Recovery Programme (ERP) in 1983. The second reviews the period following the ERP.

### 3.4.1 Period before the ERP

In 1957 Ghana gained its independence, making it one of the first countries in Africa to do so. In some ways, the Ghanaian economy has changed substantially since that date; industry and services have increased their role, and agriculture has reduced. Income in total, and also per capita, rose for a few years to 1965, fluctuated around the highest value attained for about six years, and then fell, until very recently (2006). The country's population has grown very rapidly, from a figure of approximately 7 million inhabitants at the time of independence to over 22 million in 2006.

The Ghanaian economy was quite well endowed in respect of natural resources, skills and finance at the time of independence. With a vibrant agricultural sector, not only feeding the population but also providing substantial volumes of cocoa for export, the Ghanaian economy had a solid base from which to advance. Industrial output value-added was nearly 20 per cent of GDP. Besides, before independence, education had flourished and capital had been accumulated. In 1957 Ghana's was, by developing country standards, a flourishing economy, and each inhabitant, on average, received an income of approximately US$600 in 1975 prices, comparable with incomes in South Korea and Malaysia at the time (Sowa 1993).

The subsequent history has been one of a rapidly rising population combined with a much less rapidly rising output. The first estimate of Ghana's GDP covered the year 1965 and amounted to 4.64 billion cedis, measured in constant prices of 1975 distributed among the 8 million Ghanaians this yielded an average of 580 cedis each, or approximately the same number of US dollars . Sixteen years later, in 1981, GDP per capita had fallen to 489 cedis (again in 1975 prices); both agriculture and industry had suffered, the latter more dramatically, its share of the total national output falling from 19 per cent in 1965 to 9 per cent in 1981.

From 1912 when Ghana was part of the West African Currency Board[12] up to about 1972 inflation in Ghana was quite low. For most of the period the average rate of inflation was below 10 percent. Indeed, during the period of the Currency Board, quite characteristically the rate of inflation was below 1 percent. Following independence in 1957, the rapid pace of modernisation, development of infrastructure and development of import substitution industries began to heat-up the economy. Accumulated reserves from which the initial development was financed soon run out; and with Ghana out of the Currency Board in 1958 and having established its own central bank in 1957, deficit financing through the printing of money was an obvious option. In 1964 the stock of money increased by 37.2 percent causing inflation to jump into double digits at 15.8 percent. Even though the growth in money supply slowed down substantially in the following years, the inflationary pressures, which had been generated in 1964, persisted for at least three years. One of the factors which helped to sustain the pressure on prices was a severe foreign exchange constraint faced by the country, following the rapid pace of modernisation

[12] The West African Currency Board was set up in 1912 by the British to issue the West Africa pound, the currency of British West Africa.

and development of import substitution industries, which led to shortages of most consumer items and raw materials for the newly established industries.

Nkrumah’s socialist Government was overthrown in a coup d’état in 1966, ending the government’s desire for rapid development of import substitution industries. The military Government of the National Liberation Council (NLC) signed a stabilisation package with the International Monetary Fund. Under the stabilisation programme the new administration took measures to lower the high tempo of economic activity which characterised the preceding period. In particular, it cut back public spending and the use of bank financing. The extensive state involvement in the economy was curtailed and investments reduced, leading to large-scale economic retrenchment. Meanwhile, monetary policy was tightened through interest rate increases and credit restrictions, among other things. The resultant effect of the new policy measures was deflation in 1967 followed by years of low rates of inflation but at the expense of economic growth.

This period of stabilisation was followed, during 1969-71, by a marked boost in economic activity under the civilian administration of Prime Minister Busia. Government recurrent and investment outlays increased substantially, sustained, in part, by the use of foreign reserves and external borrowing. At the same time, private participation in the economy increased. The easing of fiscal pressure coupled with a tight monetary policy kept inflation in check. Other contributory factors to holding inflation in single digits during the 1969-71 periods were a combination of marked domestic output growth and improved import supplies under a cocoa price boom in 1970 and a liberalised external trade policy. The latter policy, coupled with a downturn in cocoa prices in 1971, put enormous strain on Ghana's balance-of payments, necessitating devaluation (by 44 percent) in December 1971. This led to a coup d’état, which brought the military to power and set in motion the second phase of inflation in Ghana.

The most expansionary phase in Ghana’s economic management history was over the period 1972-82. This period witnessed a succession of regimes, largely military, which pursued highly expansionary fiscal programmes buttressed by monetary accommodation as widening budget deficits were financed from bank loans to government and parastatals. To contain the resultant inflationary pressure, extensive controls – of prices, exchange rates, interest rates, etc. – were instituted. This led to extremely distorted relative prices, economic stagnation and severe shortages of goods, with attendant strong upward pressure (suppressed or otherwise) on prices. A brief stabilisation effort under IMF sponsorship from January 1979 fizzled out in June that year as a victim of another military intervention. Pervasive economic controls and restrictions from 1972 through to 1982 bred a repertoire of malpractices, including smuggling, parallel market activities in goods and foreign currencies, and corruption. Despite the widespread regime of price controls, however, inflation averaged as high as 50 percent per annum during 1972- 82, with 1977 and 1981 recording the highest ever rates of 117 percent.

Ghanaian inflation, especially during the period 1972-82, reflected largely excessive demand pressure sustained by excessive fiscal expansion and accommodating monetary growth. But it is equally true that the problem was made worse by inadequate growth of output and supplies due to particular structural constraints faced by the economy.

Of utmost importance among these constraints was the severe foreign exchange scarcity due, in large part, to over reliance on very erratic cocoa earnings. This severely constrained the capacity to supply essential imports for consumption and production, with potential inflationary consequences.

Inadequate food production and supply was another important constraint. This was due to a catalogue of factors including: low productivity, poor storage and preservation facilities, unreliable weather conditions, inadequate marketing and distribution arrangements, fast growing population and urbanisation, and pricing policies aimed at keeping down food prices. Food price inflation arising from supply gaps had immense economy-wide inflation effects.

Furthermore, the inadequate performance of the manufacturing sector also contributed to the worsening of the inflation problem. The problems of the sector included persistence of large excess capacities (due to lack of adequate imported inputs), outdated technologies and inefficient management. The erratic supply of consumer goods added to upward pressure on prices.

For most of the period under consideration, price controls and fixed exchange rates were used extensively in an attempt to contain inflation. But this only led to suppressed prices and incentives at the producer level without removing the causes of inflationary pressures in the economy. The price distortions accentuated structural constraints in the external trade sector, and domestic production. As a result, by 1981 the economy was in very bad shape, with declining income per capita, mounting external deficits, and seriously run-down social and economic infrastructure. This second episode of inflation characterised by stagflation was at its peak in 1983.

In April of 1983, faced with a near bankrupt position, Ghana adopted an International Monetary Fund and World Bank supported Economic Recovery Programme (ERP). The ERP sought to minimise both external and domestic imbalances and put the economy on a path of sustainable growth. To this end, far reaching measures were implemented over the years, including large exchange rate corrections, price-deregulation, trade liberalisation, financial sector reforms and rehabilitation of economic and social infrastructure.

A key objective under the ERP was inflation control. Given the role of fiscal deficit financing in pre-1983 inflation, efforts were made to reduce budgetary deficits and minimise recourse to bank financing. There was a marked improvement in revenue collection although government spending was also increased to start-kick the economy. Much of the increased expenditure however was supported by external donors.

### 3.4.2 Period following the ERP

Looking at the overall changes in the Ghanaian economy since 1984 and comparing the present with the trough of 1981, the Ghanaian economy has shown a remarkable recovery. The overall measure of economic output, GDP, rose from 270.6 billions cedis in 1984 to 14113.4 billion cedis in 1997, at 1995 prices, and to 79800 billion cedis in 2004. The increase in industrial output was even more rapid, from 0.4 billion cedis in 1981 to 1.1 billion cedis 10 years later. The share of industry in total GDP was very nearly restored to its value at the time of independence; since total GDP was some 50 per cent higher than at the time of independence, total industrial output increased by approximately the same percentage.

Total investment rose from approximately 5 per cent of GDP in 1983 to nearly 17 per cent in 1991. During this time, public investment remained more or less constant at 8 per cent of GDP; the increase came about entirely through a resurgence in private investment, which rose from a negligible rate in 1981 to nearly 9 per cent of GDP in 1991 (BOG 1992).

The resurgence of industrial output, and the growth of incomes, increased the need for imports - of raw materials, capital goods and consumer goods - and the reduction of restraints on imports, through the scheme of liberalisation, has encouraged the increase. Financed in part by foreign borrowing, the deficit on the current account was contained until 1990. The figures for 1990 and 1991 particularly - suggested that the deficit on the current account reached a high level making debt servicing too expensive (BOG 1992). In 1992 Ghana was, on balance, a supplier of capital to the developed countries and to their financial institutions.

The majority of Ghana's debts are to international financial agencies and to governments in the developed countries; the eight loans which Ghana accumulated in the six year period 1983-1989 amounted to US$626 million. World Bank figures show that Ghana's total external debt exceeded US$4 billion by 1991; this figure rose to nearly US$4.3 billion in 1992. The external deficit and requirements for repayments on principal were met through additional loans. The debt figures revealed a strong reliance on official creditors, who accounted for about 92 percent of public disbursed debt, and on concessional funding, which approached 60 percent of total external debt in 1992. In addition, Ghana began to borrow on international capital markets in 1991. Nevertheless, the country's debt service ratio fell at an annual average of 25 percent in 1991 and 1992, reflecting repayment of large IMF obligations and the ending of the government's use of IMF funding at the end of 1991. An additional factor was debt cancellation by a number of leading bilateral creditors totalling over US$4 billion since 1989. Total external debt fell to US$2 billion by the end of 2006.

Thus although growth in the money stock continued to be high (averaging about 40 per cent per annum during 1983-1989, equal to the average growth rate recorded for 1972-1982 the source of the expansion during the third episode of inflation did not lead to inflationary pressures of the same magnitude as during the second phase. On average, inflation during the third phase has hovered around 25 per cent.

In 1989, Ghana was allocating approximately 10 per cent of its total export earnings to servicing official debt[13]; the servicing of unofficial debt claimed another 2 per cent of Ghana's export earnings. (BOG 1992). The annual outflow in payments to creditors surpassed the annual inflow, from both official and unofficial sources.

Therefore on the policy front Ghana's history has been one of fiscal dominance where persistent fiscal deficits have been financed by monetary accommodation. Strong inertial inflationary expectations became embedded in the economy due to high inflation and exchange rate volatility. This has allowed dollarisation to take hold and significant foreign exchange deposits are held in the banking system. Breaking inflation inertia is therefore a core challenge of monetary policy.

Moreover, significant portions of government budget deficits have typically been financed on the domestic market through the issue of Treasury bills. Over time, the deficits have led to the build-up of a large stock of public debt, which reached 31 percent of GDP in 2001 (BOG 2002). Domestic debt service payments amounted to 45 per cent of budgetary revenue and 30 per cent of the broad money stock (M2) at the beginning of 2001. This means that the economy had settled into an inherently unfavourable debt dynamic and is prone to instability. Also, a factor in that instability was that, although the central government budget deficits (and the overall public sector borrowing requirements) have been financed in large measure by significant external loans and grants; these resources are normally tied to specific conditions and disbursements are uncertain.

Finally, on the side of money balances, one special feature of the Ghanaian economy is that a large proportion of the money stock is held outside the banking system with

[13] Official debt is debt owed to a bilateral government agency or a multilateral development agency. As well as debt arising from official development assistance and other official flows, it includes former private sector debt that has been rescheduled by the official sector.

fluctuations that are highly dependent on the cocoa season**.** During this season (the fourth quarter of the year) there is a seasonal jump in the money supply that may transmit expansionary impulses, accentuating underlying inflationary pressures (through the aggregate demand channel.)

The weaknesses in the economy were exposed by commodity price shocks in 1999 and 2000. The prices of Ghana’s major exports (cocoa and gold) plummeted on international markets while the price of its major import (oil) increased, in the midst of a surge in spending and a growing budget deficit. Fiscal and monetary policy were not firm, the public sector’s borrowing led to a large build up of debt, with an increased dependence on external donor inflows that fell short. The economy plunged into high inflation and exchange rate depreciation and the currency collapsed.

When the fundamentals are not right, shifts in local investor and bank confidence, be these the result of an exogenous shock (e.g. a spike in oil prices) or a weakening in policies, could have rapid repercussions. They could induce transfers of capital abroad or initially at the very least, a shift into dollar-denominated deposits, and away from cedi currency holdings. The pressure from a significant shock to the economy is normally quickly felt on the currency exchange markets with the potential to start a depreciation and inflation spiral especially when economic fundamentals go wrong. The currency crisis that happened in 2000 when a sharp decline in cocoa and gold prices coincided with a period of fiscal expansion is very illustrative of this monetary dynamic.

The constraints that the budget imposes on monetary policy in this setting are extreme, given the increases in net domestic financing (mainly by the banking sector) of the budget and the degree of fiscal dominance of the economy. The burden on monetary policy is accentuated when policy fundamentals weaken, which tends to trigger not only capital flight but also diminished access to external financial assistance normally subject to policy conditionality. On the other hand, in this setting and given this sort of dynamic, coordination of fiscal and monetary policies is important for macroeconomic stabilisation.

An inflationary process may have the economic purpose of restoring consistency in the system of economic relationships. For example, suppose money supply increases more than the growth in real economic activity in a given economy. Economic theory suggests that prices will rise in an attempt to restore some balance between aggregate demand and aggregate supply. As long as economic agents find themselves out of equilibrium, inflation may continue.

However, high and variable inflation creates incentives for misallocation of resources and uncertainty that makes it more difficult for firms, consumers and savers to make decisions. Inflation leads to arbitrary and inequitable redistribution of incomes, it serves as a tax on incomes and hits hardest at low income groups, especially the poor as they are less flexible in responding to adverse conditions in the environment. No lasting benefits can accrue from high inflation to an economy. Persistent high inflation may cause high inflationary expectations among economic agents which in turn increases inflationary pressures. Although the Government has been pushing for single digit inflation; this is yet to become a sustainable reality.

## 3.5 The Financial Sector and Reforms

The financial system in Ghana is made up of its central bank, banks, and other financial institutions. The country's central bank, the Bank of Ghana, was established in 1957 under Bank of Ghana Ordinance (No.34). A series of amendments and comprehensive reviews culminated in the Bank of Ghana Law, 1992 (PNDCL 291). PNDCL 291 provided for a Board of Directors consisting of a Governor, two Deputy Governors, and eight directors to administer the bank. Functions provided under the law included: (i) issuance of currency, (ii) regulation of the currency, credit and banking system in accordance with government economic policy, (iii) management of external reserve, (iv) maintenance of price stability, (v) banker and financial advisor to government, and (vi) manager of public debt. Section 27 of PNDCL 291 limits temporary advances to government, although this is not specific enough to facilitate compliance.

The financial system began with the opening of the first commercial bank - a branch of British Bank of West Africa (now Standard Chartered Bank, Ghana) in 1896. In 1917, a second bank (now Barclays Bank, Ghana) opened its office in Accra. In 1953, the first indigenous bank - the Bank of Gold Coast (now Ghana Commercial bank) was established to meet credit need of indigenes. The nation's central bank - the Bank of Ghana - was then established in 1957. Thus, in the early post independence years, Ghana's financial system consisted of a central bank and three commercial banks. With the aim of fostering economic development following independence, the government established more banks - beginning with the National Investment bank in June 1963 to finance and promote industrial enterprises. By 1980, seven additional banks had been set up.

The financial sector, as with all other sectors of the economy, was heavily controlled during 1957-1983 (Leite et al., 2000) and poorly supervised. The effect was an uncompetitive, growth-stifled sector incapable of performing its intermediation role. From this weak base, sizeable adjustments in the external value of the cedi from 1983 under the ERP unavoidably exacerbated the financial difficulties of the banking system. With the aim of attaining a vibrant sector capable of satisfactory intermediation, a financial sector adjustment programme (FINSAP), a component of SAP, was designed with the support of the World Bank and initiated in 1988. FINSAP involved: (i) financial sector institutional restructuring, (ii) enhancement of the legal and regulatory framework for the financial sector, (iii) the creation of new institutions, and (iv) liberalisation of interest rates. With a sizeable proportion (40%) of bank credit by 1988 being non-performing, FINSAP reforms initially focused on the banking sector. A new banking law laying the regulatory framework for the banking system was enacted in 1987. By 1991, bank supervision had strengthened and most non-performing loans removed[14, 15]. FINSAP reforms also involved reforms to monetary management. By 1992, interest rates and credit had been decontrolled and institutional arrangements to facilitate the system of indirect

[14] This new law defined a new regulatory framework that included provisions for: minimum capital requirements, prudential lending guidelines, and stronger supervisory process. Some specifics included imposition of explicit safeguards against excessive risk taking, and standardising, broadening and strengthening reporting requirements.

[15] FINSAP policies to foster the development of non-bank financial institutions (NBFIs) were implemented in the latter years of the programme. They mainly comprised provisions for the setting up of new institutions and the design of an appropriate regulatory and supervisory framework.

monetary management put in place[16]. The system of indirect monetary management began in that year.

Ghana's financial sector increased following the re-vitalisation of the sector, to a central bank, 16 commercial banks, 113 rural banks, and 248 non-bank financial institutions (NBFI) by the beginning of 2000. The NBFIs together accounted for 32 per cent of total financial sector assets. Of these 16 were insurance companies, 1 pension fund, and 1 Stock Exchange that together accounted for 28 per cent of financial sector assets. The remaining 230 NBFIs accounted for the remaining 4 per cent of financial sector assets. They comprised 8 savings and loans institutions, 13 finance houses, 6 leasing companies, 3 discount houses, 2 building societies, 1 mortgage finance company, 1 venture capita fund, and 196 credit unions (World Bank and IMF, 2000).

## 3.6 Monetary Policy Operating Framework

The monetary policy framework of the Bank of Ghana is based on the quantity theory that relates money growth to inflation, assuming a constant velocity of money and full employment. The framework embodies three targets: the final target (inflation), the intermediate target (broad money), and an operating target (net domestic assets of the central bank or reserve money) (Wampah, 1998).

Monetary policy design involves the determination, in consultation with the Ministry of Finance, of targets for GDP growth, inflation, and the balance of payments. Based on these targets and an assured velocity of money, the central bank derives the implied money supply using the simple quantity theory relationship. Prior to monetary management reform in 1991, the implication for credit expansion so derived from the simple quantity theory relationship was distributed amongst banks as a credit ceiling. The credit controls were, from 1971, supplemented by controls in commercial bank interest rates.

[16] The institutional arrangements involved: the creation of a market in government securities in 1987; the setting up of supporting institutions, notably discount houses; and the unification of cash reserve requirements on demand and time and saving deposits.

Controls in credit and interest rates were discontinued following reforms in monetary management, and the central bank from 1992 began to control the money supply principally through open market operations (sales and purchases of Treasury bills). This meant that over the period 1992-2000, the main instrument of policy was the interest rate on the 91-day Treasury bill. Supplementary instruments included: discount window operations, foreign exchange operations, reserve requirements, and from 1998, repurchase and reserve repurchase transactions (Wampah, 1998)[17].

The intermediate target has evolved to reflect the widening scope of the definition of money; the operating target has also been changed to reflect the need for a closer relationship between the operating and intermediate targets, such that the attainment of the operating target would to a high degree imply the attainment of the intermediate target (Wampah, 1998). During 1992-1996, the intermediate target was M2, i.e. currency plus quasi-money. In 1997, the central bank switched to a broader definition of the money supply, M2+: which is M2 plus foreign currency deposits. The change was in response to the rapidly growing foreign currency deposits in the balance sheets of commercial banks and the need to monitor them as a potential source of demand and therefore inflation.

## 3.7 Monetary Policy Background

Monetary policy in Ghana has changed considerably since the launch of the Economic Recovery Programme (ERP) in 1983, in line with changes in the financial system. Whilst the objective aspect of monetary policy – price stability – has remained basically unchanged, there have been substantial changes elsewhere, especially with regard to the instruments used. The instruments of monetary policy

[17] The central bank's use of cash and liquidity ratio requirements to regulate commercial bank liquidity dates back to February 1969. From 1990, the cash ratio was progressively lowered until it reached its lowest level of 5 per cent in 1993. In 1996, the cash ratio was raised to 10 per cent, but lowered to 8 per cent in 1997 when foreign currency deposits were added to the total deposit base for the calculation of reserves. In July 2000, in response to rising inflation and a sharp depreciation of the cedi, the ratio was raised to 9 per cent. The discount window facility is primarily used to meet occasional shortages in the market, and operated at the instance of the deficit bank. The central bank uses a deposit standing facility at its instance to absorb liquidity from the market as well. Both instruments are priced relative to the Treasury bill rate. The central bank's foreign exchange operation is through outright sales and purchases or through swaps; and undertakes either one of these within the confines of the reserve money target.

have been improved and more indirect and market based instruments have been developed. With respect to policy targets, although the intermediate target continues to be broad money, the definition of the money supply has been adjusted to take account of new financial assets that resulted from the liberalisation and innovation process and functioned as close substitutes for monetary assets (Wampah, 1998).

One of the main constraints on monetary policy for most of the ERP/SAP review period has been the need to accommodate unplanned fiscal requirements. Also since 1994, monetary management has been additionally burdened by large liquidity injections into the economy concentrated in the last quarter of the year, mainly through the foreign loan inflow earmarked for the purchase of cocoa. This is aggravated by fiscal pressures which make monetary management in the last quarter of every year very complicated.

### 3.7.1 Objectives of monetary policy

The overriding goal of monetary policy in Ghana is price stability, although this was not stated explicitly in the Bank of Ghana (BOG) law, 1992 PNDCL 291. The price stability objective has become explicit since 1996, when the BOG refocused its mission and adopted a Mission Statement as follows: "to pursue sound monetary and financial policies aimed at price stability so as to create an enabling macroeconomic environment for the promotion of sustainable economic growth."

The monetary policy setting in Ghana is typical of a small open developing economy. In an open economy, the conventional wisdom is that standard channels for the transmission of monetary policy actions are through aggregate demand, expectations which affect inflation via wage and price setting behaviour, the exchange rate, via the interest parity conditions dependent on the difference between domestic and foreign interest rates, and expected future changes in exchange rates. All these work in a complex interaction through the system into the price level.

A number of practical considerations specific to the economy are important for the conduct of monetary policy:

• **The first is the degree of openness of the economy to trade.**
The estimates are that commodity imports account for 50 percent of GDP and most payments transactions are denominated in US dollars. Cocoa and gold account for 60 percent of export earnings; and oil imports about a third of imports. Taxes related to international trade account for about 23 percent of total government revenue. Trade liberalisation has been accompanied by a reduction in tariffs to relatively low levels with low dispersion across commodities. This structure of trade means that the economy is very exposed to shocks in international commodity markets (BOG 2005).

• **Second, the exchange rate is freely floating on the forex markets and interest rates are fully liberalised.** The interbank exchange rate for the cedi is freely determined on exchange markets. There is no intervention by the central bank except to safeguard a minimum reserve target. The rate coexists with daily quotations for bank notes in an atomistic retail market of foreign exchange bureaux operators. Total recorded transactions on this market account for some 10 percent of the daily volume of trade, and these are based on firm, but somewhat more volatile exchange rate expectations which tend to feed into general market expectations.

• **Third, the exchange and payments system is a liberal one.** There are no restrictions on payments and transfers for current international transactions (Ghana has accepted the obligations under Article VIII of the Articles of Agreement of the International Monetary Fund). The freedom of payments transactions makes domestic prices of traded goods and the exchange rate highly responsive to market forces and demand pressures.

• **Fourth, prices of goods and services are market determined.** With the exception of key public utilities and petroleum products which are regulated under a market-based pricing mechanism, all other prices are market determined. Public utilities were heavily subsidised before the review programme of 1983. Adjustments have been discrete, large and episodic rather than systematic and flexible over time, with a significant impact on pricing and wage-setting behaviour and shifts in the price level.

• **Finally, the economy is surrounded by countries in the CFA franc zone.** These countries have an established record of low inflation and currency stability. Their currency, managed by a common central bank, had been, de facto, irrevocably pegged to the French Franc (under the guarantee of the French Treasury) and now to the euro. Many of these countries produce the same primary commodities for export based on similarly designed producer pricing systems. Unrecorded cross-border trade is active, with the potential for price-related diversion of export products, taking advantage of any arbitrage, including trading on the foreign exchange (especially) bureaux market.

### 3.7.2 Strategy for monetary management

#### *3.7.2.1 Monetary targeting*

The central bank's strategy for inflation control is based on the Monetarist view that inflation is mainly a monetary phenomenon. Several studies of the Ghanaian economy have established that a significant proportion of the variation in prices is explained by movements in monetary aggregates (see Ewusi 1997; Kwakye and Lawson, 1996; Wampah, 1998 ). Targeting money supply growth is therefore an appropriate method of targeting inflation in the Ghanaian economy. The programming framework used by the Bank is derived from the quantity theory equation that relates the rate of monetary growth to inflation given a constant velocity of money and full employment.

The growth and inflation targets for a particular year are based on financial programming determined in consultation with the Ministry of Finance (MOF). The quantity theory of money adopts a demand management approach where prices adjust to movements in money supply. It is assumed that velocity (v) is stable and can be reliably predicted (outside the model).

#### *3.7.2.2 Types of target*

The Bank of Ghana's monetary management framework basically has three targets; the ultimate or final target, the intermediate target and the operating target.

The ultimate goal of the central bank is to maintain price stability and thus the target is usually set in terms of inflation rates. The intermediate target is money supply, which is derived from the quantity theory identity. The particular monetary aggregate used varies from country to country, and in Ghana has evolved over the years. In Ghana, M1 was used as the intermediate target for the greater part of the period prior to 1983. However, as quasi money (Time and Savings Deposits) grew and became increasingly a near-perfect substitute for demand deposits, BOG switched to using M2 as the intermediate target. Finally, in 1997, the central bank started using the broader target of M2+, defined as the sum of M2 and foreign currency deposits. This was in response to the rapid growth of foreign currency deposits on the balance sheets of commercial banks and the need to monitor them as a potential source of demand and therefore inflation.

During the period of direct controls, the central bank was able to control money supply directly. The BOG was able to limit commercial banks to specific credit ceilings, thus ensuring that the money supply target was met. In a liberalised system of indirect controls, however, the central bank must operate through another variable over which it has greater control. This variable, called the operating target, must be closely related to the intermediate target, such that attaining this target would translate into achieving the intermediate target.

The main operating targets used by central banks are the net domestic assets of the central bank (NDACB) and Reserve Money (RM). In Ghana, NDACB was initially used. In the financial programming framework, a floor is usually set for the Net Foreign Assets of the central bank (NFACB). Earlier in the reform period, NFACB was considered a major source of liquidity injection since, during this period, export earnings and bilateral/multilateral flows were low. The major source of injection was net claims on Government and the private sector. Thus, targeting (NDACB) was considered appropriate in restraining Government as well as commercial bank credit to the private sector. When exports recovered and the international community's confidence in Ghana was restored, foreign inflows became a major source of injection and the sole concentration on NDACB became inadequate. To deal with the situation, the central bank shifted to the use of RM as its operating target. RM is related to the intermediate target (M2) through the money multiplier (m) as follows:

**M2 = m*(RM)**

Thus, if m can be projected fairly accurately or is stable, the M2 target can be achieved by keeping to the corresponding RM level. RM can be influenced through open market operations (OMO) or foreign exchange reserve management (FEMO). The relationship can be written as follows:

**M2 = NFACB + NDACB** and **NDACB = NCGCB + OINCB**

Where **NFACB** is the net foreign assets of the central bank

**NDACB** is the net domestic assets for the central bank

**NCGCB** is net credit to government by the central bank

**OINCB** is other items (net) of the central bank.

**NIBPCB** is net indebtedness of the central bank to commercial banks and the public

Open market sales (or primary issues) of government paper or central bank bills will have contractionary effects on NCGCB and NIBPCB, while purchases will have the opposite effect. Similarly, central bank sales of foreign exchange will reduce NFACB, while purchases will expand it. Thus OMO and FEMO can be used by the central bank to achieve a desired level of reserve money. As is clear from above, the assumption of a stable multiplier forms the basis of the central bank's monetary management strategy, since m is the link between reserve money and money supply. If m is unstable or cannot be predicted reliably, then the M2 target cannot be achieved even if the RM target is achieved.

Under the poverty reduction and growth facility (PRGF) agreed upon with the IMF in June 2001, the performance criterion for the monetary sector has been shifted from reserve money to the NDACB. This stems from the fact that inflationary pressures in the Ghanaian economy in 2000 emanated mainly from domestic credit creation, hence the need to monitor the net domestic assets of the central bank.

### 3.7.3 Instruments of monetary management

In a system of direct controls, which was the system until 1987, the main instruments of monetary management were direct controls in the form of ceilings on commercial bank credit to the private sector and regulation of interest rates. The ceilings on commercial bank credit were both bank and sector specific. The central bank also regulated interest rates by stipulating floors and ceilings for deposit and lending rates respectively. High reserve requirements were also imposed during this period. These controls had their own attractions, the most obvious one being ease of implementation.

Under this system all the central bank had to do was determine the money supply growth for the year, based on economic growth and inflation objectives; determine the credit growth that would be consistent with the money supply growth figure; distribute this credit growth among banks based on certain criteria, and sit back to monitor compliance of the banks to the guidelines. Thus, at the beginning of each year, BOG sent out general policy guidelines as well as bank-specific ones. The general guidelines included interest rate regulations and distribution of credit by economic sectors (agriculture, industry, etc.) The specific guidelines stipulated ceilings for the total credit allowed each bank. Penalties were applied by the Banking Supervision Department (BSD) on non-conforming banks. Monetary management was therefore simple and straightforward.

Despite its simplicity this system of monetary management had several disadvantages. First, high unremunerated reserve requirements, coupled with credit ceilings, led to the accumulation of a large pool of excess liquidity in the banking system. Since there was no avenue for investing these funds, the banks had no incentives for mobilisation of savings. Furthermore, the ceilings on lending rates were often kept low to keep the cost of borrowing low, especially to Government. Thus, interest rates were generally negative in real terms, a further disincentive to savings. The system of direct controls, therefore, contributed to the deterioration in the banking system by increasing transaction costs and discouraging financial intermediation, leading to a misallocation of resources.

A variety of instruments used by the central bank in the conduct of monetary policy include reserve requirements, open market operations (OMO), repurchase and reverse repurchase agreements (repo, foreign exchange reserve management and foreign exchange swaps or sale and buy back), and auctions of government debt instruments of various maturities and more recently, in March 2002, the Bank of Ghana Prime Rate. These are traditional market-based, non intrusive ways to absorb liquidity from the system as well as inject it into the system. The Bank has the capacity to use these instruments to influence the cost of borrowing and returns on assets and to shape the incentives for market participants to hold more cedi balances in the banks and fewer foreign exchange deposits domestically or abroad.

Reserve money is the operational target used in the monetary policy framework in Ghana supported by a set of broad economic indicators**.** The central bank regulates reserve money to achieve a desired growth rate of broad money supply consistent with the programmed inflation and real GDP growth rates. There is in principle no intervention in the exchange market except to safeguard a minimum reserve target and, as indicated above, the exchange rate normally floats freely.

#### *3.7.3.1 Primary Reserve requirements*

Ghana has a long history of using reserve requirements for both prudential and monetary management purposes. During the period of direct controls, they were used as a supplement to credit controls. The central bank continued to use reserve requirements after the introduction of indirect monetary control. However, the ratio, base and method of calculation have evolved over the years.

The ratios applied for demand deposits were higher than those for savings and time deposits (quasi money). The ratios discriminated between types of deposit prior to March 1990. The idea was to encourage commercial banks to mobilise long-term funds, which could be channeled into long term lending. After 1990, the two ratios were merged into a single ratio on total deposits (demand, time and savings deposits). Finally in 1997, the coverage was extended to foreign exchange deposits. This was in response to the central bank's decision to target the broader definition of money supply, M2+, which also includes foreign currency deposits. Thus, the central bank would have better control over the money supply, while at the same time leveling the playing field for the mobilisation of both domestic and foreign currency deposits.

The level of the ratio itself fluctuated over the years, reflecting liquidity conditions in the banking system, and reached its highest level of 27 per cent in 1990. After 1990, the ratio was progressively lowered until it reached its lowest point of 5 per cent in 1993. The reserve ratio was again raised to 10 per cent in 1996 and lowered to 8 per cent in 1997 when foreign currency deposits were included in the total deposit base for the calculation of reserves. In July 2000 in response to rising inflation and the sharp depreciation of the cedi, the ratio was raised to 9 per cent. In August 2006, the secondary reserve was abolished but the primary reserve ratio remains at 9 per cent.

#### *3.7.3.2 Reserves against foreign currency deposits*

Two main issues frequently come up with foreign currency deposits: whether the reserves against these deposits should be held in foreign or domestic currency; and whether foreign currency deposits should be included in the monetary target. Generally, when reserves against foreign currency deposits are held in domestic currency, banks may be exposed to foreign currency risks. However, Hardy (1997) points out that denominating some reserves in foreign currency can complicate monetary policy implementation by removing some of the central bank's control over base money. The second issue of whether foreign currency deposits should be included in the monetary target is an empirical one, depending on the substitutability of foreign and domestic currencies.

The central bank introduced reserve requirements against foreign currency deposits in 1997 with the main aim of leveling the playing field for the mobilisation of domestic and foreign currency deposits. As in the case of cedi (local currency) deposits, requirements against foreign currency deposits are presently fixed at 9 per cent, and are not remunerated. However, BOG requires banks to keep reserves in foreign currency deposits in cedis for a number of reasons. First, keeping reserves in foreign currency would be operationally difficult because the central bank would have to monitor the banks' several nostro accounts in different currencies. Also, there was a need at the time to tighten liquidity further in order to sustain the downward trend in inflation. This measure apparently provided an avenue for the central bank to tighten liquidity conditions without appearing to increase overall reserve requirements.

In the application of this policy, banks with large foreign currency deposits have found themselves increasingly having to augment their reserve requirements at the Bank of Ghana as a result of the depreciation of the domestic currency.

The Bank of Ghana (BOG) has used reserve requirements extensively to support its monetary management. The methodology the BOG follows generally conforms to acceptable norms in terms of base, method of computation and conformity in the treatment of all types of reserves. However, the level of the ratio is still considered to be high at 9 per cent. It is generally accepted that the optimal level should be close to the level of reserves kept by banks for clearing purposes, which in Ghana is estimated at between 2 per cent and 3 per cent. Because of the continued existence of excess liquidity in the system, it is unlikely the ratio will be reduced immediately.

### 3.7.4 Measurement of reserve requirements

For monetary targeting and prudential purposes, reserve requirements are more effective if they are observed contemporaneously. However, for developing countries where significant lags exist in reporting, it may be necessary to have lags between the base and maintenance period.

Hardy (1997) argues that an averaging method is preferable to a day-to-day maintenance method, since the latter compels banks to hold excess reserves and thus affects the stability of the multiplier and further complicates the conduct of monetary policy. In Ghana, the contemporaneous observance and daily maintenance of reserve requirements was used until 1994, when it was replaced by a one-week lagged observance. The seven-day week averaging method also replaced the daily observance at the same time.

Two items are usually included in the definition of reserves, namely cash in the tills of banks (vault cash) and balances with the central bank. A third item which is sometimes included is call money in the interbank market. In 1986, the Bank of Ghana included all three items in the definition. In 1989, call money was dropped and finally in 1996 the definition was narrowed to include only balances with the central bank. This was done to avoid the difficulty of monitoring compliance when cash in the tills of banks is included in the definition.

### 3.7.5 Open market-type operations

The Bank of Ghana intervenes mainly through the primary auction of Treasury bills and BOG bills in implementing monetary policy, a process also referred to as open market-type operations. The system has undergone several transformations. Originally, weekly auctions of Treasury bills and BOG bills were held on Fridays, with the amount offered based on the difference between projected and targeted reserve money, maturing bills as well as public sector borrowing requirements (PSBR).

Initially the weekly auctions were open to banks and to the non-bank public, although the non-bank public had to submit their bids through their bankers. Pricing at the auction is based on the multiple price auction system, where bids are arranged in descending order and the higher prices are allotted first until the offer is exhausted. Each bidder pays the price he quotes. Investors could also purchase on tap directly from BOG between tenders (auctions) at the weighted average price declared at the preceding auction. The tap was supposed to be open only when targets had not been met, but were, in practice, always open in view of the large liquidity overhang. The tap between tenders was closed to all banks in March 1996, but remained open to the non-bank sector.

This situation discouraged the development of the secondary market, and therefore in 1997, BOG abolished the tap for the non-bank sector as well in Accra, the nation's capital. Tap sales, however, continue to operate at BOG's regional branches.

#### *3.7.5.1 The Primary dealer system*

BOG introduced the wholesale auction system in March 1996. Tenders for Treasury bills became restricted only to primary dealers comprising commercial banks, discount houses and four brokerage firms. A well-functioning primary dealer system should help develop the secondary market. The primary dealers should be able to underwrite the whole issue at the tender. They should also be leaders in the market and act as market makers in government and central bank securities, subject to compliance with an established code of conduct and standard best practice. In this regard, primary dealers should stand ready to give firm price quotations. In return, the dealers are granted certain privileges such as access to special financing arrangements.

The system has not worked well in the country. The auctions are often under-subscribed and the primary dealers make no effort to promote secondary market activity. BOG has in a way contributed to the problems by continuing to maintain a window for the discount of government securities. The tap continues to be open to the non-bank sector in parts of the country.

*3.7.5.2 Money market instruments*

There has been a recent shift in composition from BOG bills to Treasury bills, which is the Government of Ghana (GOG) Instrument, although the main instruments over the years have not changed significantly. Table 3.7.5.2, below, shows that the proportion of BOG bills in the total stock (in billions of cedis) increased from 34 per cent in 1990 to a peak of 80 per cent in 1994 and then fell sharply to less than 4 per cent in March 1998. This followed a deliberate central bank policy of replacing BOG bills with Treasury bills, apparently because of the Government's increasing concerns over interest payments on these instruments. Thus, from 1996 Treasury bills became the main instrument of intervention while at the same time serving the purpose of Government's debt management. The process of conversion was largely completed by March 1998 as shown in Table 3.7.5.2 below, with the remaining stock comprising 30-day bills, 3-year and 5-year bonds, and the last two of which are not actively traded on the market.

**Table 3.7.5.2**

| Money market Instrument:1990-1998 | | | | | |
|---|---|---|---|---|---|
| Year | GOG Instrument | | BOG Instrument | | Total |
| | Amount | Per cent | Amount | Per cent | Amount |
| 1990 | 73.6 | 66.5 | 37.0 | 33.5 | 110.6 |
| 1991 | 58.2 | 32.2 | 122.7 | 67.8 | 180.9 |
| 1992 | 92.2 | 38.4 | 148.1 | 61.6 | 240.3 |
| 1993 | 113.1 | 25.3 | 334.5 | 74.7 | 447.6 |
| 1994 | 119.7 | 20.0 | 479.5 | 80.0 | 599.2 |
| 1995 | 221.2 | 25.0 | 656.8 | 74.8 | 878.0 |
| 1996 | 665.8 | 56.2 | 518.2 | 43.8 | 1184.0 |
| 1997 | 1490.2 | 88.4 | 194.9 | 11.6 | 1685.1 |
| 1998* | 1982.4 | 96.4 | 73.9 | 3.6 | 2056.3 |

*March 1998 GOG- Government of Ghana BOG- Bank of Ghana

Source Bank of Ghana

The phasing out of the BOG bills brought into focus the issue of over-financing of the deficit, with the difference between the deficit and the actual issue representing the central bank's monetary intervention. BOG has addressed this issue by opening a separate account called OMO-Treasury bills, into which the proceeds from intervention are put and sterilised. This procedure, however, raises the problem of reconciliation between the stock of bills in the register and what actually goes to finance the budget, a situation which may raise questions about transparency. In spite of the problems, BOG's decision to switch to Treasury bills appears justified in view of the Government's increasing concerns about the interest bill. There was therefore the danger that in future the Government might decide to stop paying the interest cost on BOG bills, an action that might affect the profitability of the central bank and potentially compromise the conduct of monetary policy. The central bank may address this issue by introducing secondary instruments, such as repos for its monetary policy intervention. This would require prior actions by the central bank to develop the secondary market by putting in place the framework and instruments, establishing a book entry system, and acquiring a portfolio of assets for use on the market. This system would ultimately eliminate the cost to the Government of BOG's monetary intervention.

### 3.7.6 Trends in broad money supply growth

Trends in the rate of growth of money supply in Ghana display the distinctive characteristics of a last-quarter hump, largely as a result of the external pre-financing of cocoa purchases. Whereas the cumulative rate of growth of money in the first three quarters of the year falls generally below 25 per cent, the nature of financing the cocoa purchases brings this figure to an average of 40 per cent each year for the period 1994-1997 (BOG 1999).

The disbursement of foreign exchange for crop purchases coincides with the purchase of the bulk of the major cocoa crop in the last quarter of the year. The net foreign asset (NFA) of the Bank of Ghana increases significantly in the last quarter of the year and the Bank has been unsuccessful in sterilising this increase in many years. In 1998 however there was an improvement as less pressure from the fiscal side allowed better monetary management in the last quarter of the year. This was due to an improvement in government finances, partly as a result of better day-to-day monitoring of the government's position with the central bank. This resulted in a shift in government deficit financing from the central bank to the commercial banks and the public (BOG 1999). The table below shows trends in money supply and its growth rate (year-on-year) from 2002 to 2006.

**Table 3.7.6**

| Year | Month | M2Plus | M2PlusGROWTH |
|---|---|---|---|
| 2002 | Q1: | 10745.2000 | 4.8500 |
| 2002 | Q2: | 11259.8000 | 9.8200 |
| 2002 | Q3: | 12135.7000 | 18.4200 |
| 2002 | Q4: | 15368.1000 | 49.9600 |
| 2003 | Q1: | 15209.8000 | 41.5000 |
| 2003 | Q2: | 16042.7000 | 42.5000 |
| 2003 | Q3: | 16445.9000 | 35.5200 |
| 2003 | Q4: | 21137.9000 | 35.8000 |
| 2004 | Q1: | 21248.0000 | 39.7000 |
| 2004 | Q2: | 22490.3000 | 40.2000 |
| 2004 | Q3: | 23285.1000 | 41.6000 |
| 2004 | Q4: | 26667.2000 | 26.0000 |
| 2005 | Q1: | 26336.7000 | 23.9000 |
| 2005 | Q2: | 27108.1000 | 20.5000 |
| 2005 | Q3: | 27005.6000 | 16.0000 |
| 2005 | Q4: | 30417.5000 | 14.1000 |
| 2006 | Q1: | 31500.8000 | 19.6000 |
| 2006 | Q2: | 34079.4000 | 25.7000 |
| 2006 | Q3: | 36079.5000 | 33.6000 |
| 2006 | Q4: | 42219.5000 | 38.8000 |
| 2007 | Q1: | 42809.6000 | 35.9000 |
| 2007 | Q2: | 44350.0000 | 30.1000 |
| 2007 | Q3: | 4826.3000 | 33.9000 |
| 2007 | Q4: | 5750.6000 | 36.3000 |
| 2008 | Q1: | 5959.4000 | 39.2000 |
| 2008 | Q2: | 6197.8000 | 37.0000 |
| 2008 | Q3: | 6940.2000 | 43.8000 |
| 2008 | Q4: | 8062.3000 | 40.2000 |

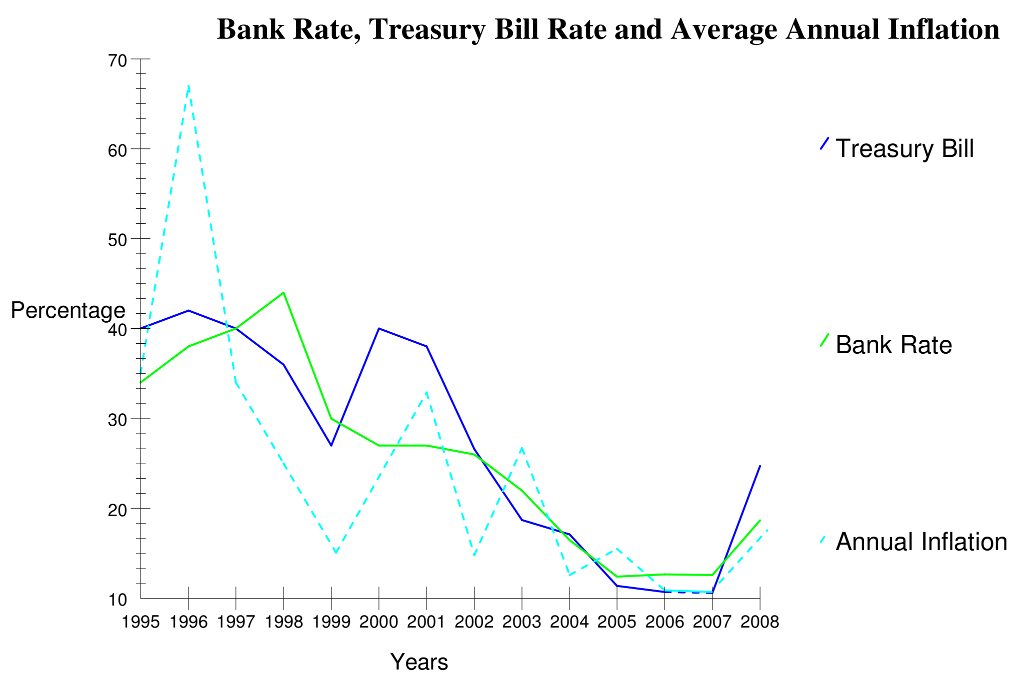
Source: (BOG Website on 02/06/2009)

### 3.7.7 Money market rates

Although a lot has been achieved in laying down the infrastructure for market intervention, there has not been much success in achieving money supply and inflation targets. Again, the main problem has been the continued presence of the Government on the market, as well as the inability of the central bank to vary rates to achieve the desired targets. Figure 3.7.7 below shows 91-day Treasury bills rates, the Bank Rate and the inflation rate from January 1995 to December 2006. As is evident from this, the Bank Rate has remained stable over most of the period, although market conditions (as measured by the inflation rate) fluctuated during the period. For the whole of 1997, the monthly average Bank Rate remained at 42.8 per cent in spite of a declining inflation rate. In 1995 and 1996, the real Treasury bill rate was negative for long periods.

The Ghanaian experience has revealed that market participants respond only to the central bank's actions, which come either through movements in the Bank Rate or the results of preceding auctions. Thus, even if all other indicators (inflation, growth, etc.) point to a change in rates, the market participants appear to wait for signals from the central bank before reacting themselves.

**Figure 3.7.7**




Source: Bank of Ghana

A possible explanation of such inertia on the part of market participants is that the long history of controls (especially regulated interest rates) has rendered them dependent on the central bank to develop their own expertise in this area. It appears therefore that the central bank has a major role to play in removing this inertia, and encouraging banks to follow market trends. In particular, the central bank should use the Bank Rate (or other indicators) actively in signaling its policy stance, rather than allowing the rate to remain stable for long periods while underlying macroeconomic conditions change.

BOG is however limited in its ability to use the Bank Rate effectively due to cost considerations. Since in Ghana the cost of intervention is financed by the Government, it (the Government) may resist interest rate increases to levels that are necessary to clear the market. A necessary condition for improvements in money market performance, therefore, is that the Government's borrowing requirement should decline significantly. Secondly, the BOG should intensify the use of secondary instruments instead of primary issues for monetary intervention, thus reducing the financial burden on the Government.

### 3.7.8 Central Bank Independence

"The agency theory of Central Bank Independence (CBI) and virtually all other theories on CBI postulate that a negative relationship between CBI and inflation is robust. For inflation targeting, an independent Central Bank (ICB) is an obvious pre-requisite. Sub-Saharan Africa can also inflation target by suitably embracing the prescribed monetary policy framework"- Oyedokun Agbeja (2007)

Ghana's parliament passed into law a Bank of Ghana Act at the end of 2001 to strengthen the central bank in the conduct of monetary policy. This Act gives operational independence to the BOG. This historic Act specifies among other provisions that:

• The primary objective of the Bank is to maintain price stability "independent of instructions from Government or any other authority". This has refocused the central bank on the major task of inflation control and away from the developmental activities which characterised the Bank's operations in the past.

• A Monetary Policy Committee is responsible for formulating monetary policy, which should bring transparency to the central bank's operations and its communications with the public.

• Government borrowing from the central bank in any year shall be limited to 10 percent of its revenue, which ties the hands of government and the central bank in a way that is much stricter than the 20 percent ceiling which prevails in the CFA zone countries, for example.

The new statutory mandate of the central bank is seen as firmly rooted in a resurgence of public interest in economic policy and a heightened aversion for inflation and awareness of how much stability contributes to raising the standard of living of its people. The Bank of Ghana Act sought to address the prevailing concern that instability and weaknesses in the regulatory framework have accounted for the poor economic performance and stifled the private sector.

The central bank in the midst of fiscal dominance was thought to be responsible, to some extent, for a situation in which inflation and exchange rate losses had not only eroded the capital of many enterprises but also inhibited their ability to take advantage of business opportunities. Also constrained was the economy's ability to attract and retain domestic and foreign capital and investment on the scale needed to sustain rapid productivity and income growth. In short, inflation was seen as the root cause of the economic difficulties, and a justification for an independent central bank (BOG 2002).

### 3.7.9 Bank of Ghana Prime Rate

The central bank introduced a "Prime Rate" in March 2002 to tighten the link with liquidity management and inflationary expectations and the transmission of monetary policy actions. It is the rate at which the central bank would provide overnight funds to banks and thus should influence the interbank market rate and interest rates generally consistent with its monetary policy stance.

The Bank's Monetary Policy Committee (MPC), modelled after that of the Bank of England, sets interest rates every other month, and communicates its decision to the public. In its work, it has established a commitment to an anti-inflation strategy using inflation targeting (Bank of Ghana Act 2002).

The MPC meets over three days to examine and analyse a considerable amount of data on the economy, including the fiscal outlook, monetary and inflation developments, external sector, financial stability, and the real sector of the economy in reaching its decision on the Bank of Ghana Prime rate. Such information is required to give context to the decision and to provide a basis for the market participants also to formulate a view. There is a popular notion that with its eye on inflation, the MPC does not give a lot of attention to the real sector of the economy.

The MPC argues it analyses a lot of data on real sector developments and undertakes surveys of 45 companies covering all sectors of the economy every two months. The objective of creating a low inflation environment is to allow sustained economic growth to take place, although low inflation is good for its own sake and essential for growth.

BOG introduced a new economic indicator, the Composite Indicator of Economic Activity (CIEA) to address the existing gap in information about developments in the real sector of the economy. CIEA measures real sector activity including output of selected key enterprises, industrial electricity consumption, domestic VAT, port activity, imports, exports, and employment contributions. BOG also undertakes consumer confidence surveys across all ten regions of the country, as well as regular surveys of business to complement the CIEA. The business sector surveys cover all sectors of the economy, including agriculture. In addition, surveys of consumer confidence are undertaken every other month across all ten regions. The MPC considers these and other developments in the real sector when reaching its decision on the interest rate.

A Press Conference is held by the Committee at the end of each bi-monthly meeting, and a lot of statistical information in the form of reports is released to the general public. This process of communication is a novel departure from past practice and seeks to provide as much information on the economy and the stance of monetary policy for the press/public to take a stake in its objectives. This process helps in shaping expectations.

## 3.8 Summary

The literature on monetary policy in Ghana indicates that the central bank bases its monetary policy on the quantity theory, relating money growth to inflation assuming a constant velocity of money and full employment.

Prior to monetary management reform in 1991, the implication for credit expansion so derived from the simple quantity theory relationship was distributed amongst banks as a credit ceiling. The credit controls were, from 1971, supplemented by controls in commercial bank interest rates.

Following the ERP and reforms in monetary management, controls in credit and interest rates were discontinued and the central bank from 1992 has relied on a variety of instruments in the conduct of monetary policy, including reserve requirements, open market operations (OMO), repurchase and reverse repurchase agreements (repo, foreign exchange reserve management and foreign exchange swaps or sale and buy back), and auctions of government debt instruments of various maturities and more recently, in March 2002, the Bank of Ghana Prime Rate.

These are traditional market-based, non intrusive ways to absorb liquidity from the system as well as inject it into the system. The Bank has the capacity to use these instruments to influence the cost of borrowing and returns on assets and to shape the incentives for market participants to hold more cedi balances in the banks and fewer foreign exchange deposits domestically or abroad.

The Bank of Ghana's ability to use the Bank Rate effectively is however limited due to cost considerations. Since in Ghana the cost of intervention is financed by the Government, it (the Government) may resist interest rate increases to levels that are necessary to clear the market, which can influence monetary policy effectiveness.

# Chapter 4

# Theory and Literature on Monetary Policy

The chapter provides the theory and literature on: first, monetary policy rules; second, the responsiveness of commercial bank retail rates to changes in the policy interest rate; and third, the monetary transmission mechanism. It presents a three-part review of the relevant theory and literature that underpins the empirical analysis in this thesis (in Chapters, 5, 6, and 7).

Section 4.1 presents the theory and literature on monetary policy rules and evaluates the issues in the following sub-sections: the dynamic inconsistency problem and proposed solutions (4.1.2), the definition and formulation of monetary policy rules (4.1.3), interest rate rules (4.1.4), and issues relating to the design of interest rates rules and estimates of interest rate responses from the empirical literature (4.1.5). Section 4.2 turns to the literature, (mainly empirical), on the responsiveness of commercial bank retail rates to policy interest rates. Section 4.3 then discusses the transmission of monetary policy, focusing on the channels of monetary transmission (4.3.2) and the empirical literature (4.3.5). Section 4.4 concludes the chapter.

## 4.1 Monetary Policy Rules - Theory and Literature

### 4.1.1 Introduction

Poole (1999) argued that human behaviour is better organised by rules[18]. This assertion, according to the current literature on monetary policy, applies to monetary policy conduct. This realisation emerged, however, only after a considerable period of pro and counter argument dating back to Simons (1936). Simons, an early enthusiast of rules for the conduct of policy, advocated clear and firm rules for monetary policy conduct in his paper "Rules versus Authorities in Monetary Policy".

[18] All aspect of our behaviour, economic and otherwise, are governed and organised by various rules. The most routine aspects of our lives becomes unpredictable and even chaotic when not governed by well defined and generally accepted rules – William Poole (1999)

Two decades after Simons, Friedman (1953, 1959) proposed the first definitive rule - a constant money growth rule - for monetary policy conduct. The rule stipulates that the money supply be increased by a constant per cent (k, equal to the expected growth of potential GDP minus the expected rate of increase of velocity) annually, and be independent of subsequent economic and financial considerations. Friedman argued that given the long and variable lags in the transmission of monetary policy, the constant money growth rule would avoid the instability of discretionary monetary policy and deliver low inflation. On the other side of the divide, the proponents of discretionary policy rejected definitive rules for what they do. They stressed the importance of policy adaptability as a means of keeping an uncertain environment under control. In their view, it is precisely because the economy is subject to uncertain shocks, and policies can have diverse effects, that discretion in policy implementation is desirable (Guitán, 1994).

Using game-theoretic approaches, Kydland and Prescott (1977, hereafter KP) and subsequently Barro and Gordon (1983, hereafter BG) however, changed the focus of the rules versus discretion argument. They demonstrated the superiority of rules over discretion for monetary policy conduct and put an end to the idea that a policy rule necessarily involves a fixed setting of the monetary authority's instrument variable. This literature has been the reference for all other arguments over rules for the conduct of monetary policy. The recommendation from this literature is that superior results in terms of social welfare are obtained if a government, through their central bank, follows a re-commitment device: notably, if they follow *a priori* rules. However, unlike the rule of the Friedman-type where there is no scope for ongoing policy-making (i.e. excluding discretionary policy-making), rules that have ensued from the KP and BG literature allow for on-going decisions.

### 4.1.2 The Problem and Proposed Solutions to Dynamic Inconsistency

#### *4.1.2.1 The Dynamic Inconsistency Problem*

Theoretical and empirical research has substantially demonstrated the absence of a long-run relationship between inflation and unemployment (Friedman, 1968; Leiderman and Svensson, 1995; Taylor, 1999d; Khan, 2003). However, most monetary theories of the business cycle show a short-run trade-off in the sense that changes in inflation are associated with changes in the unemployment rate (Taylor, 1999d; Khan, 2003). In particular, inflation tends to fall when unemployment is above the natural rate or GDP is below potential; and inflation tends to rise in the opposite scenario. The existence of this short-run trade-off is widely believed to be associated with the presence of sticky wages and prices. The likelihood that an expansionary monetary policy, while it may increase output and employment in the short-run, could raise inflation is the essence of the dynamic inconsistency problem, developed principally by KP[19].

#### *4.1.2.2. Solutions to the Dynamic Inconsistency Problem*

KP propose its solution, that is for the monetary authority to follow a rule. As architects of the dynamic inconsistency problem, KP demonstrated that even when there was agreement on the social objective function, optimal control theory or discretionary policy, namely the period-by-period re-optimisation on the part of the monetary authority, though consistent, is sub-optimal. That is, it does not result in the social objective function being maximised. This is because current decisions of economic agents depend in part upon their expectations of future policy. As such, it is only when these expectations are invariant to future policy that control theory would be appropriate. Thus, by relying on some policy rules, economic performance will be improved. Using an inflation-employment example, KP demonstrated that control theory only results in inflation with no reduction in unemployment, thus failing to achieve optimal equilibrium.

BG confirmed the need for rules as a solution to the dynamic inconsistency problem of discretionary policy. They developed the argument of KP by including a theory of expectations formation. BG argued that governments, through their central banks, are often (rationally) tempted to violate their own pre-announced inflation targets in order to reduce unemployment. However, because agents form expectations rationally, they will generally deduce that inflation targets will not be met and hence raise their inflation expectations accordingly before any policy is implemented. This makes discretionary/activist policy ineffective in increasing employment and output, while at the same time leading to a rise in inflation. The public policy implication of

[19] Khan (2003) gives budgetary concerns as another reason for the dynamic inconsistency problem. The argument is that where the budget is monetarily financed, a government may choose to inflate to maximise revenue from money creation.

the KP and BG research is that, to control inflation, central banks should be bound by rules in order to build public confidence in announced inflation targets. This helps to reduce inflation and unemployment.

Alternative proposals have however, questioned the KP and BG solution of a rule to the inflation bias problem[20]. The alternative solutions have tended to rely on institutional arrangements that might leave the central bank free to pursue activist counter-cyclical stabilisation policies, while simultaneously inducing it to avoid the inflationary bias of discretionary monetary policy making as identified by KP and BG. One such solution is reputation or credibility (e.g. Canzoneri, 1985; Rogoff, 1985). For instance, Rogoff (1985) argues for the appointment of a central bank governor with much greater concern for price stability (relative to output) than society as a whole. Given that, the aggressive central banker proposed by Rogoff may reduce average inflation but at a cost of higher output variability. This line of research took the direction of examining the role of incentives contracts - e.g. Persson and Tabellini (1993) and Walsh (1995). Using the principal-agent framework, Walsh (1995) proposes a contract that directs the central banker to behave in a rule-like manner and not increase output variability. Blinder (1997), however, questions the approach because the principal (government) may not have the incentive to enforce the contract on the agent (central bank), being the time inconsistent government that necessitated the need for an incentive package in the first place.

Another institutional solution is granting central bank independence (CBI) - a logical solution, as an underlying assumption for the time inconsistency literature is the belief that the central bank is subject to undue political pressure. However, evidence on whether independent central banks can avoid inflationary bias has been inconclusive. For example, significant dis-inflation amongst many developed

[20] Some criticisms of the rule solution, as noted in Bofinger (2001 p.185), include the following. First, whether it is realistic to assume that a central bank will pursue an employment objective that implies lower unemployment than the natural rate. Second, whether it can be assumed that the social welfare function is identical with the preferences of private individuals. Third, whether the phenomenon of time inconsistency can be observed despite identical preferences of private individuals and the central bank. McCallum (1995) also considers the time inconsistency argument and its recommendation that rules are necessary to remove the inflation bias to be flawed, in the sense that the monetary policy maker, aware of the implications of judgement for inflation, can just “do the right thing” and respond to inflation shocks so as to deliver the desired outcome.

countries was attained from the end of the 1970s to the 1980s without formal institutional changes (Friedman and Kuttner, 1996; Fuhrer, 1997a). Furthermore, empirical evidence also casts doubts on the robustness of the correlation between CBI indexes and inflation, real growth or unemployment. While Grilli *et al (*1991), Alesina and Summers (1993), and Cukierman *et al. (*1993) find that improved inflation performance under CBI is not associated with slower growth; others like Fuhrer (1997a) and Campillo and Miron (1997) do not find such results. Moreover, even where favourable results (CBI vis-à-vis inflation and output growth) have been found, Fuhrer (1997a) observes that in general they hold only in the simplest bivariate cross-country regressions. Once other cross-sectional attributes are controlled for, the correlations disappear. In addition, for the favourable result, doubts have been raised with regards to causation (Leiderman and Svensson, 1995). The argument is that while evidence may reflect the causal effect of CBI on inflation, this could be the result of other factors that affect both inflation and output growth.

Considering the drawbacks of the institutional solutions, it appears that the dynamic inconsistency problem is best solved with monetary policy feedback rules, supplemented by institutional arrangements. At this point, it suffices to define "monetary policy feedback rule" or simply "monetary policy rule" and the two broad approaches to formulating a rule for monetary policy.

### 4.1.3 Monetary Policy Rule

#### *4.1.3.1 The Definition Monetary Policy Rule*

A monetary policy rule has been defined as  a plan that states as clearly as possible the circumstances under which a central bank should change the instrument of policy (Taylor, 1993, 2000) or as a formula that specifies instrument settings designed to keep target variables close to their specified path (McCallum, 1999a). It is expected that the policy rule would be applicable for an indefinitely large number of decision periods. This long term view for a policy rule has brought a further dimension to the concept of monetary policy rules. This is the idea that the policy rule should have a "timeless perspective" (Woodford, 1999; McCallum, 2000; Jensen and McCallum, 2002).

Woodford (1999) explains that with forward-looking price adjustment, even if the central bank's target for output does not exceed the natural rate, there would still be inefficiency unless the optimisation is conducted in a timeless perspective. That is, there would be inefficiency unless monetary policy is conducted as if current macroeconomic conditions were not known and optimisation had been made in the distant past as far as the state of the economy was concerned. The importance of Woodford's "timeless perspective" exposition is that it allows the possibility of alterations to the monetary policy rule when new information suggests that the central bank's outlook of the economy needs revision. Thus, current data can be used in model estimation and can be responded to by the rule. It is only the optimisation process of deriving the rule that needs to be independent of current conditions.

Furthermore, there is another perspective on the concept of monetary policy rules by Svensson (2003). Defining a monetary policy rule as systematic policy, Svensson argues that it encompasses two types of rules: instrument rules and target(ing) rules. In the language of Svensson, an instrument rule expresses the instrument of policy as a prescribed function of pre-determined or forward-looking variables or both. McCallum and Taylor's definitions of policy rule would be considered as instrument rules by Svensson. In contrast, but again in the language of Svensson, a targeting rule is a commitment to a particular loss function or particular target variable(s). Thus, the essential difference between a targeting rule and an instrument rule is that while the targeting rule amounts logically to the selection by the analyst of a model and an objective function, an instrument rule reflects the analyst's hypothesis that the central banker, whatever his model or objective function, would achieve satisfactory results if he were to implement the rule.

#### *4.1.3.2 The Formulation Monetary Policy Rule*

Monetary policy rule definitions follow logically from the two main approaches to formulating the rule: the optimal control approach and the robustness approach. The optimal control approach to formulating monetary policy rules involves developing an appropriate macroeconomic model of the economy and then conducting optimal control analysis to determine, once and for all, the best policy rule for the economy in question. Naturally, the resulting optimal policy rule depends on the precise model structure. The resulting rule would be classified as a targeting rule by the Svensson concept; examples are Feldstein and Stock (1994) and Svensson (1997).

However, there is an absence of professional agreement on the appropriate specification of the macroeconomic model suitable for monetary policy issues, because different macroeconomic models give different implications for monetary policy, and the optimal control approach boils down to a decision on the appropriate model of the economy. Some economists argue that the better approach to formulating a policy rule is to search for one that possesses robustness, in the sense of yielding desirable outcomes in policy simulation experiments conducted with a wide variety of models, but not necessarily optimal in any given model. An example of such an approach is Bryant *et al*. (1993). These authors, employing varied assumptions about the structure of the economy (eight different large scale macroeconomic models of the US economy), perform a series of simulations in which the instrument of policy is adjusted in response to deviations from predetermined targets in: (i) the exchange rate, (ii) money supply, (iii) nominal output, and (iv) a combination of inflation and real output. The research shows that rules that target inflation and output are most successful in terms of reducing and stabilising output and price variability. Rules emanating from such a robustness exercise would be instrument rules according to the Svensson classification.

There is the need to specify the goals of monetary policy for either the optimal control or robustness approach (McCallum, 1999a). In that regard, important issues include whether a central bank should keep inflation close to some normative value, what the normative value should be, whether the central bank should react to the output gap, whether the central bank should react to other variables, what the nominal anchor should be, and what the instrument of policy should be.

Monetary policy is acknowledged to be most effective in the presence of a firmly established nominal anchor, the extent of effectiveness dependent on the degree to which the nominal anchor is understood by the public (Bernanke *et al*., 1999).

Generally nominal anchors are either price or quantity based. While price anchors include the exchange rate, the price of gold, the composite price of a basket of relevant commodities for a country and the inflation rate, the principal quantities are monetary aggregates and nominal income. Regarding the policy instrument, two have been considered - money stock and interest rate - leading to two types of policy rules: money stock feedback rules and interest rate feedback rules. Money stock feedback rules are extensions of the Friedman proposal to include feedback elements as a way to correct past mistakes or gradually adjust to permanent shifts in velocity.

Many countries turned to the short term interest rate as the instrument of policy, following the finding in many countries that the relationship between monetary stock and inflation and output was unreliable (the velocity instability problem). As such, the emphasis in modern monetary policy and policy literature and analysis is interest rate rules (Bali and Thurston, 2002; McKibbin, 1997; McCallum, 1999a).

### 4.1.4 Interest Rate Rules

Taylor (1993) suggests a simple interest rate feedback rule drawing on the findings of Bryant *et al*. (1993) that has a price anchor of the form shown in Equation (4.1) that successively mimicked US monetary policy during 1987-92. The subsequent findings that the Taylor (1993) rule satisfactorily explained other industrialised country interest rate settings has generated much interest in the rule, as argued by Woodford (2001) that the rule has since been subjected to considerable attention, both as an account of actual policy in the United States and elsewhere, and as a prescription of desirable policy.

#### *4.1.4.1 The Taylor Rule*

The Taylor (1993) rule can be specified in a general form as:

$$i_t = \Pi^{*} + r + \alpha\,(\Pi_t - \Pi^{*}) + \beta(y_t - \tilde{y}_t) \qquad (4.1)$$

where $i_t$ denotes the central bank's operating interest rate target (or instrument of policy), $r$ is the equilibrium real interest rate, $\Pi^{*}$ is the long run target inflation rate, $\Pi_t$ is the inflation rate measured by the GDP deflator, $y_t$ is the log of real GDP, $\tilde{y}$ is the log of potential output (identified empirically with a linear trend).

This rule recommended adjusting the level of the policy instrument in response to four factors. The first is the long-run inflation target, the inflation rate that would prevail on average over time although the actual inflation rate may differ. The second factor is the equilibrium real interest rate, *r*. Added together, the two factors provide the benchmark long-run nominal interest rate.

The other two factors in the Taylor rule address the way policy should respond in the short run to changing circumstances - namely to changes in inflation and output. The first of these is the inflation gap ($\Pi_t$-$\Pi^*$) adjustment factor, $\alpha$, ($\alpha$>0). Since $\alpha$ is greater than zero, the rule recommends raising the interest rate above the nominal rate if inflation is above its target. The second factor is the output gap ($y$-$\tilde{y}$) adjustment factor, $\beta$, ($\beta$>0). Similarly, $\beta$ larger than zero implies raising the interest rate above the long–run nominal interest rate if GDP is above potential. The sizes of $\alpha$ and $\beta$ determine the vigour with which monetary policy responds to deviations of inflation from its target and output from potential.

In his specific formulation of the rule, Taylor set $\alpha = 1.5$, $\beta = 0.5$, r = 2 per cent, and $\Pi^* = 2$ per cent. He uses judgment rather than econometric investigation. The Taylor rule with the interest rate in nominal terms is:

$$i_t = 0.04 + 1.5\,(\Pi_t - 0.02) + 0.5(y_t - \tilde{y}_t) \qquad (4.2)$$

and the rule with the instrument in real terms is:

$$i_t - \Pi = 0.02 + 0.5\,(\Pi_t - 0.02) + 0.5(y_t - \tilde{y}_t) \qquad (4.3)$$

The Taylor rule implies that in the event of a sustained increase in inflation by *k* per cent, the nominal interest rate will eventually be raised by more than *k* percent as specified in Equation (4.2): specifically, one-and-a-half times *k*. That the interest rate response to inflation should exceed a factor of one has been referred to as the Taylor principle by many (e.g. Woodford, 2001; McCallum, 2001a; Carlstrom and Fuerst, 2003).

Taylor's principle therefore explains that a rise in inflation above target should lead to an increase in real interest rates (one-half of a percentage point for every percentage point that inflation is above target). This would reduce aggregate demand and inflation pressures and bring the economy back towards targeted equilibrium. These features of the Taylor rule ensure determinacy[21]. A policy rule that does not obey this principle would reduce the real interest rate and add to inflationary pressures. The end result would be that inflation has no anchor that will pull it to its long-run target and, as such, the economy is further pushed away from targeted equilibrium (Woodford, 2001; Clarida *et al*., 1998, 2000). Bernanke and Woodford (1997) also argue that indeterminacy is equally present if a rule calls for an aggressive response of interest rates to information variables. In this instance, there is a policy "overkill" effect that may result in an oscillating equilibrium.

A number of other researchers have considered rules of the Taylor type; among them were Henderson and McKibbin (1993) who proposed a rule of the form:

$$i_t = i + \alpha\ [\Pi + y - (\Pi^* + \tilde{y})] \qquad (4.4)$$

However, Taylor's important contribution was to spell out the normative and positive implications of his rule. On the normative side, the rule is consistent with the main principles of optimal monetary policy. First is a gradual adjustment of inflation to target. Second, the interest rate responds to the output gap as opposed to the level of output. As such, the rule calls for a countercyclical response to demand shocks and accommodates shocks to potential GDP that do not affect the output gap. On the positive side Taylor showed that, with certain parameter values, the rule provides a reasonably good description of US monetary policy over the period considered.

Whilst Taylor's rule in the general form shown in Equation (4.1) agreed that the coefficient on the inflation term should be greater than one for determinacy, the

[21] That is, the Taylor rule, by virtue of its being a feedback rule from endogenous state variables, and with a coefficient on the inflation term obeying the Taylor principle, assures determinacy.

optimal coefficient size is unknown. Likewise, whilst there is agreement that the coefficient on the GDP gap should be positive, the optimal size is not known (Poole, 1999; Taylor, 1993). Other issues of the rule also remain. These include the appropriate definition of inflation, i.e. the index to use and the time period over which to measure it[22], and the appropriate measurement of potential GDP.

### 4.1.5 Formulation of Interest Rate Rules

A number of macroeconomists argue that inadequate knowledge about the way the economy works limits the benefits of model-specific policy rules e.g. McCallum, 1999a; Christiano and Gust, 1999; and Clarida *et al*., 1999. In response, some research has examined varied policy rules in varied models of the economy to identify rules that are likely to be both efficient and robust when used as a guide for the conduct of monetary policy (Christiano and Gust, 1999; Romer, 2001). Such research includes the NBER sponsored study in Taylor (1999b), the Riksbank-IIES (1998) policy rule research, Levin *et al*. (1999), and Bryant *et al*. (1993). These studies investigated issues including: the optimal size of the parameter associated with inflation and output gaps, measurements of inflation and the economy's productive potential, whether the rule should be extended by other variables, robustness of simple rules against complex rules, and whether the rules should be forward-looking. The concept of inflating targeting relates to issues of whether the rule should be forward-looking.

#### *4.1.5.1 Optimal Size of the Parameters*

Optimal inflation and output gap coefficients issues have received considerable research time. For example, Stock (1999), Sargent (1999), and Williams (1997) quoted in Taylor (1999a) as well as Ball (1999a) have all argued that the optimal weights chosen to minimise the variance of inflation and output might be higher than the weights of the Taylor rule. However some other work, e.g. the NBER policy rule research, has argued otherwise. This finds that the benefit of larger weights is not robust to varied model specifications, judged by the variability of inflation, output gap, and interest rate.

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[22] Using inflation over a short period like a month introduces random noise into the interest rate; but using inflation over a long period, like five years, would yield a rule that responds too slowly to changing conditions (Poole, 1999).

#### *4.1.5.2 The Economy's Productive Capacity*

It has been observed (e.g. Woodford, 2001) that in theory, a wide variety of real shocks (e.g. technology shocks, variable productivity of investment opportunities, and changes in attitudes towards labour supply) would affect the growth rate of potential output, and would do so not necessarily following smooth trends. As such, the output gap measure that is relevant for welfare may be quite different from simple detrended output commonly employed in monetary policy rules. Taylor (1993) measured the output gap as the deviation of output from linear trend, with trend output use as a proxy for potential output. McCallum (2001b) adds that in addition to the weaknesses associated with the measurement of potential output, many other competing concepts like "natural rate", "NAIRU", "market-clearing", and "flexible-price" output exist in the literature, which only confuse even more the issue of measuring the gap in output. He is of the view that from the perspective of dynamic optimisation analysis, the flexible-price concept (i.e. the output level that would prevail in the absence of nominal stickiness), a concept that has hardly been used, is the most appropriate.

Measurement of the output gap is important as uncertainties have been found to result in poor rule outcomes. An example is Orphanides *et al*. (2000), who find that errors in the measurement of output gaps led to a substantial deterioration in economic performance. In their view, such a problem could be mitigated with a reduced coefficient on the gap in output in the rule. Along the same line of argument, Orphanides (1999) finds that misperceptions about the economy's productive capacity, rather than the stance of monetary policy in the 1970s as is generally claimed, was the primary cause of US inflation in the 1970s. Similarly, Kozicki (1999) finds that the Taylor rule produces different results depending on the measure of potential GDP used.

#### *4.1.5.3 Inflation and Output Measurement*

Should inflation and output be entered in the rule in lagged form, as contemporaneous values, or as expectations? Taylor proposed measuring inflation as average inflation over the four quarters ending in the current quarter and output as the current quarter's value, but the use of contemporaneous values has been questioned given that current inflation and output are unknown when the central bank sets interest rates. Given this, the rule implications for using lagged data as opposed to current data has been investigated in some research, e.g. the NBER (1999) policy rule research reported in Taylor (1999b). The finding, in line with Romer (2001), is that lagged variables do not perform better than variables in contemporaneous form.

Some economists have also suggested that inflation and output are best measured as expected values to better reflect the practice of central banks forming policy based on their expectations of these variables. On this as well, there are diverging views. For example, Taylor (1999a) argues that these forecasts, based on current and lagged data, are no more forward-looking than "backward-looking rules". Laxton and Pesenti (2003) develop a variant of the IMF's Global Economic Model suitable to analyse macroeconomic dynamics in open economies, and use it to assess the effectiveness of Taylor rules and inflation-forecast-based (IFB) rules in stabilising variability in output and inflation in the Czech Republic. Their findings suggest that a simple IFB rule that does not rely upon any direct estimates of the equilibrium real interest rate and places a relatively high weight on the inflation forecast may perform better in small open economies than conventional Taylor rules. In support of Taylor's line of argument, Levin *et al.* (1999) find from their robustness study that rules that incorporate forecasts of output gap and inflation yield, at most, small improvements over optimal rules based on contemporaneous and lagged variables.

In addition to whether inflation should be used in the rule as forecast or contemporaneous inflation, is the availability of varied measures of inflation. The Taylor rule uses the percentage change in the price deflator for GDP; alternatives, however, includes consumer price inflation (CPI) inflation and core inflation. Empirically, different measures have been found to yield different outcomes (e.g. Kozicki, 1999).

#### *4.1.5.4 Taylor Rule Extension*

The Taylor rule is a stable, simple feedback rule. The issue is whether the equilibrium determined by such a policy rule is a desirable one. For one, there may be the need to consider additional stabilisation goals (Woodford, 1999, 2001). To investigate if more desirable results of the Taylor rule ensue when extended, the literature has either subjected some extended rules to robustness analysis or has discussed the merits and demerits of extending the Taylor rule by these variables. Variables that have been considered include: money stock, lagged interest rate, exchange rate, fiscal stance, and stock prices. Each of the proposed extensions is discussed in turn.

*Role of Money*

Since a monetary aggregate has usually been used either as an intermediate or operating target of monetary policy, it has logically been claimed (e.g. Dotsey and Hornstein, 2003; and Friedman, 2006b) that optimal monetary policy may respond to the behaviour of money if it contains useful information about the underlying state of the economy[23]. Some empirical estimates of the Taylor rule have thus included a monetary aggregate. Clarida *et al.* (1998)'s extension of the Taylor rule by a money supply term finds the variable significant for: Germany (coefficient size of 0.7), Japan (0.07), and the US (0.53), with the coefficients associated with inflation and output gap remaining unchanged for Germany and Japan. For the US, however, the significance of the money supply term is associated with a decline in the coefficient on the inflation gap. Friedman and Kuttner (1996) also find a significant central bank response to money growth for the US. Schächter and Stokman (1995), however, find weak central bank response to the variable in Germany.

*Lagged Interest Rate*

Central banks in practice, adjust the interest rate much more cautiously than optimal polices derived under an environment of certainty predict (Clarida *et al.*, 1999). This tendency of central bankers to adjust interest rates cautiously (i.e., to adjust interest rates mainly in sequences of small steps in the same direction and with relatively few reversals of direction) is referred to as interest rate smoothing. A number of researchers have shown that a policy rule that includes the lagged interest rate of the form shown in Equation (4.5) captures the last twenty years' data well.

$$i_t = (1-\rho)[\alpha + \beta\pi_t + \gamma x_t] + \rho i_{t-1} + \varepsilon_t \qquad (4.5)$$

[23] Friedman extends this role to credit as well.

Where $\pi = \Pi\text{-}\Pi^*$, $x = y\text{-}\tilde{y}$, $\alpha$ is a constant, and $\rho \in (0, 1)$ is the interest rate smoothing parameter that reflects the degree of lagged dependence on the interest rate. Clarida *et al., (*1999) further argue that interest rate smoothing is also present through smaller coefficients on inflation and output gap. Reasons for central bank interest rate smoothing include: data and model uncertainty, errors associated with the measurement of key macroeconomic variables (Sack and Weiland, 2000; and Clarida *et al*., 1999) to achieve leverage over long term interest rates[24] (Rotemberg and Woodford, 1997; Goodfriend, 1991); and to avoid financial market disruption (Goodfriend, 1991).

Rudebusch (1995), Judd and Rudebusch (1998), Clarida *et al.* (1998, 2000), and Bleaney and Lisenda (2001) for US, UK, Germany, and Botswana, all have empirical estimates that strongly support the phenomenon of interest rate smoothing. These papers found inertial coefficients between 0.7 and 0.95. Analysing the direction of interest rate changes, the studies showed that central bank interest rate changes were more likely to be followed by another change in the same direction than by a change in the opposite direction. Rudebusch (1995), however, qualified this for the USA. He observed that the hazard rate for another change in the same sign fell as the length of time since the last change increased.

*The Exchange Rate*

Exchange rate is an important variable in the monetary transmission mechanism. Taylor's exclusion of an exchange rate variable in his rule appears justified for the large and comparatively closed economy it was designed for. However, this exclusion may not necessarily be appropriate for small open economies, the reason being the acknowledged importance of the variable in the monetary transmission mechanism of such economies (e.g. Lewis and Mizen, 2000).

Explaining exchange rate response as an information variable for future inflation on the one hand and directly targeting the exchange rate on the other, Clarida (2001) argues that both require the policy maker to raise interest rates in response to a depreciating currency. That is, even if a country does not target the exchange rate

[24] It is argued that the dependence of the current interest rate on the lagged interest rate permits the central bank to manipulate long-term interest rates and hence aggregate demand with more modest movements in short-term interest rates than would otherwise be required.

directly, the monetary authority's desire to stabilise inflation forecasts should lead it to raise nominal and real interest rates when a currency is weakening and lower the same when a currency is strengthening. Similarly, Lewis and Mizen (2000) argue that the indirect effect of the exchange rate for inflation must be considered in some form in designing interest rate rules.

Ball (1999b) proposes a modification to the Taylor rule to do just that. He replaces the interest rate instrument with the weighted average of the interest rate and the exchange rate and secondly includes lagged exchange rate as an additional right hand side variable. This modification of the Taylor rule is referred to in the literature as the monetary conditions index (MCI). The MCI effect is argued by Taylor (1999a, 1999c) to be equally achieved by adding the current and lagged exchange rate to the right hand side of the Taylor rule that has the interest rate as the instrument. Ball (1999b) finds support for the MCI: holding inflation variability constant, output variability is reduced by about 17 per cent relative to the simple Taylor rule. Guender (2001), however, is an example of research that does not find support for the MCI.

Some empirical estimates of Taylor-type rules that have investigated the importance of the exchange rate include Bleaney and Lisenda (2001), Clarida *et al*. (1998), and Schächter and Stokman (1995). Bleaney and Lisenda (2001), using Botswana data, find the exchange rate (measured as the deviation of the log of the real rand-pula exchange rate from trend wrongly-signed and insignificant. Extending their baseline policy reaction function for the Bundesbank by the real DM/US dollar exchange rate, Clarida *et al.* (1998) find the exchange rate correctly-signed and significant, but with a minute coefficient (0.05) while the coefficients on the baseline variable remain unchanged. Additionally, Clarida *et al.* (1998)'s estimate of an analogous specification for Japan similarly finds the real yen/US dollar exchange rate to be correctly-signed, significant, and of a small quantitative effect (0.09).

Schächter and Stokman (1995) find the nominal DM/US dollar exchange rate insignificant in their estimated reaction function for the country in contrast to the finding for Germany in Clarida *et al.* (1998). However, the authors argue that their finding could be due to the inclusion of the US short-term interest rate in the regression: a variable that is highly correlated with the exchange rate. Dennis (2003) also finds that the optimal policy rule for the Australian economy includes the real exchange rate.

*Fiscal Policy*

Economists have argued that an economy's monetary authority cannot prevent inflation by its control of base money creation if faced with an uncooperative fiscal authority that generates a continuum of primary deficits e.g. Sargent and Wallace (1981). Assuming the fiscal authority is the dominant party, Sargent and Wallace deduced that even a determined central banker would be forced to create a monetary base along the path that is inflationary when a non-inflationary path is intended. Despite challenging arguments e.g. McCallum (1999a), there is now the appreciation that there is hardly hope of establishing a credible monetary policy if fiscal policy is out of control in the sense of an exploding debt/GDP ratio (Allsopp, 2002). Similarly, Taylor (1996) argues that the theoretical literature is clear that greater fiscal discipline which reduces government debt and lowers deficits should be associated with lower inflation. Further, Lønning (1997) and Leith and Wren-Lewis (2000) indicate that a stabilising fiscal policy is needed for an attempt at disinflation through strict monetary policy. These arguments seem to suggest that it is necessary, or at least desirable, for the monetary authority to take account of fiscal behaviour when designing its monetary rule. Empirical estimates of Taylor-type rules, however, do not show much extension by a fiscal variable. Schächter and Stokman (1995), who estimate such an extension, found the Bundesbank to have responded insignificantly to the fiscal stance of the federal governement.

*Stock Prices*

There have been arguments to suggest that the central bank, at least, observes movements in stock prices because of their potential impact on the macroeconomy (e.g. Rigobon and Sack, 2003). Bernanke and Gertler (2000) contribute to this argument with a suggestion that the central bank should respond to movements in stock prices only to the extent that they affect expected inflation. However, others (e.g. Cecchetti *et. al.,* 2000) have advocated a more direct response, where monetary policy corrects any perceived misalignment in asset prices to reduce the likelihood of asset price bubbles. This direct reaction to stock prices is questioned by Mishkin and

Schmidt-Hebbel (2001) on the grounds of the doubtful presumption that the central bank is better placed to know the appropriate asset values compared with the private market. But the argument for stock prices as an information variable in the policy rule can be analysed from a broader perspective. This has to do with the index underlying the compilation of inflation itself. Bofinger (2001, based on Edey 1994 p.122) argues that from a theoretical perspective, it is preferable to measure price stability using an index that is representative of all monetary transactions. This argument seems to suggest that the central bank should at least consider trends in the share price when setting interest rates.

*Inflation targeting*

Inflation targeting[25] is defined in some parts of the literature as a monetary policy rule (e.g. Bolinger, 2001). Others disagree (e.g. Bernanke *et al.,* 1999) and argue it is not a rule. Bernanke *et al.* (1999) explain that as inflation targeting does not provide simple mechanical operating instructions to the central bank, but requires the central bank to use structural and judgmental models of the economy in addition to whatever information it deems relevant to pursue its price stability objective, it is not a rule. Inflation-targeters also put some weight on other important macroeconomic objectives, thus, are not "inflation nutters" in the language of King (1997). The most visible other objective is stabilising the output gap. However, the constrained discretion of the inflation targeting framework does not lead to the problem of inflation bias, as inflation targeting central banks do not normally have output targets that exceed potential output (Svensson, 2002).

Whether inflation targeting is a rule or framework, relative to the standard-type rules, the three strongest arguments for inflation targeting put forward in the literature are

[25] Inflation–targeting was first introduced in New Zealand in 1990, spreading quickly to Canada in 1991, the UK in 1992, Sweden, Finland, Australia in 1993, and Spain in 1994. Finland and Spain stopped using inflation-targeting in 1999 when they relinquished monetary policy with the adoption of the euro. Amongst emerging market economies, the earliest adopter of inflation targeting is Chile in 1990, with inflation in excess of 20% (Mishkin, 2000). South Africa adopted the framework in 2000. The regimes were introduced as a way of reducing inflation from previous high levels after disappointing monetary targeting (e.g. New Zealand and Canada) or as a way of providing a new nominal anchor after having been forced off a fixed exchange rate (e.g. UK, Sweden, and Finland). The inflation targets are usually set within a 2-3 percentage point band, reflecting the imprecision of monetary control of inflation, while giving the authorities a well-defined goal. Some countries have gone for point estimates e.g. the UK with 2.5% for Retail Price Index (RPI) and 2% for Harmonised Index of Consumer Prices (HICP).

that it (i) explicitly acknowledges that low and stable inflation is monetary policy's primary goal and publicly announces explicit quantitative inflation targets that are to be achieved over some time horizon, (ii) provides monetary policy with a clear and easily understood nominal anchor, (iii) relative to simple Taylor-type rules that respond to a small subset of information about the economy and call for judgment as and when required, inflation targeting uses comprehensive information to forecast inflation and output before interest rate decisions are made. Other positive features of inflation targeting are its high degrees of transparency and accountability. (Bernanke *et al*., 1999; Svensson, 1997, 1999, 2002).

In an attempt at formalising the idea that in practice inflation targeting central banks aim to stabilise inflation around some targets and put some weight on stabilising output relative to potential, Batini and Haldane (1999) extend the Taylor rule to include forward-looking dimensions that mimic monetary policy behaviour among inflation targeting central banks. The specified rule is:

$$r_t = \gamma r_{t-1} + (1-\gamma) r^* + \vartheta (E_t \Pi_{t+j} - \Pi^*) \qquad (4.6)$$

where $r_t \equiv i_t - E_t\Pi_{t+1}$ is the short-term ex-ante real rate of interest, $i_t$ is the nominal interest rate, $r^*_t$ is the equilibrium real interest rate, E the mathematical expectations operator, and $\Pi^*$ is the inflation target. According to this rule, the monetary authorities control nominal interest rates so as to hit a path for the short-term real interest rate $(r_t)$ and by implication the path of those variables that would affect the attainment of the final inflation objective. As such, deviations of expected inflation from target elicit remedial policy actions: the authority's policy choice variables being the parameter triplet $\{j, \vartheta, \gamma\}$.The parameter $\gamma$ reflects the degree of interest rate smoothing; the parameter $\vartheta$ is a feedback parameter, with higher values reflecting a more aggressive policy response for a given deviation of the inflation forecast from its target. Finally, $j$ is the targeting horizon of the central bank when forming its forecast. Batini and Haldane (1999) argue that the size of these three parameters together determine the speed with which inflation is brought back to target following inflationary disturbances. Because they influence inflationary transition paths, these policy parameters affect the dynamics of output. Specifically, the targeting horizon, $j$, and the feedback parameter, $\vartheta$, principally help secure a degree of output smoothing. Thus, the parameters can be chosen to ensure that an inflation-forecast based rule better reflects the authority's preferences where they care about output as well as inflation. This makes inflation forecast targeting and forward-looking Taylor rules closely related concepts.

Some estimates of forward-looking Taylor rules (which include interest rate smoothing) e.g. Clarida *et al.* (1998, 2000) and Nelson (2000) have been found to conform to *a priori* notions of monetary policy conduct in the countries investigated. Nelson (2000), using UK data, estimates a near-zero nominal interest rate response to inflation for the period of relaxed monetary policy (1972-76) while for the period of astute conduct of policy (1992-97), as expected, an inflation coefficient above unity is found together with a coefficient on output of 0.5. Clarida *et al.*(1998)'s estimation for Germany, Japan, USA, UK, and Italy also find inflation coefficients that are largely in excess of unity while the coefficients on output gap, although positive, are lower than the 0.5 assumed in the Taylor rule.

Clarida *et al*. (1998) augment the forward-looking Taylor rule with lagged inflation. They find this variable to be insignificant, while the coefficients on the forward-looking term are largely unchanged. This finding, they suggest, signifies the need to reject backward-looking Taylor rule specifications in favour of forward-looking ones. However, the finding could be due to multicollinearity problems as it includes both lagged and forward-looking inflation terms.

*Simple rules against complex model-specific rules*

Levin *et al*. (1999) explain that even with the incorporation of all state variables, complex rules perform only slightly better than simple ones and the optimality of the complex rule is due to the rule exploiting model-specific properties. Thus, when the optimal rule is simulated in another model, the properties of the new model, likely to be different, may cause the optimal rule to work poorly. The likely superiority of simple rules over complex model-specific rules has been the subject of many robustness studies. These studies find that simple rules of the general Taylor-type are superior: they perform nearly as well as complex optimal rules and are more robust across models.

### 4.1.6 Summary

Analysis of strategic behaviour provides the principal economic argument for policy rules or frameworks. It is proposed that the less dominant player in a game has much to gain from the pre-commitment of the more dominant. In the absence of such commitment, the dominant player may not credibly take a later course of action that will not be in his interest when the time comes to take that action.

Economists such as Kydland and Prescott (1977) and later Barro and Gordon (1983) and others applied this principle to monetary policy, assuming that it is feasible to exploit the short-term inflation output trade-off by creating some inflation with the view to raising output. Such analysis found that attempted monetary surprises would lead to higher expected and actual inflation with no gain in output. However, by committing in advance not to create inflation, the policy maker can lower expected and actual inflation. Building on the benefits of pre-commitment the time inconsistency literature advances, Taylor (1993) proposed a simple monetary policy rule, that when followed could eliminate this problem. The Taylor rule, when applied to industrialised country data, was found to be an adequate description of monetary policy during periods when inflation control was the primary objective of policy. The rule has subsequently been subjected to substantial research to investigate the benefits of various modifications to it. What can be deemed the representative finding is that non-model-specific simple rules, responding to few variables, produce superior results compared with complex model-specific rules.

This thesis extends the Taylor rule to Ghana where inflation control is now the primary objective of monetary policy. It uses simple rules to assess the effectiveness of monetary policy conduct following the financial sector adjustment programme initiated in 1988 by investigating inflation targeting in the strictest sense, by the baseline variables (inflation and output gap) and finally by broader information set.

Following this section, is a review of the empirical literature on the responsiveness of commercial bank retail interest rates to changes in the policy interest rate: the first phase of the transmission mechanism of monetary policy to the real economy.

## 4.2 Responsiveness of Commercial Bank Interest Rates to the Policy Interest Rate

### 4.2.1 Introduction

The use of the policy interest rate to influence commercial bank retail interest rates and, in turn, the spending behaviour of economic agents is the central tenet in the conduct of monetary policy. In this regard, an implicit assumption is that a change in the policy interest rate would lead retail banks to reflect immediately the magnitude of change in their interest rates, particularly in their lending rates. However, this assumption may not necessarily hold. Retail banks could react speedily or sluggishly to changes in policy interest rates; and international evidence from the empirical literature suggests some sluggishness in the response of commercial bank interest rates to changes in central bank policy interest and/or money market rates in the short run. In the long run, however, the studies find higher pass-through. Examples of the empirical literature in this area include: Hannan and Berger (1991), Cottarelli and Kourelis (1994), Borio and Fritz (1995), Mester and Saunders (1995), Heffernan (1996), Scholnick (1996), Sander and Kleimeier (2002), Mojon (2000), Greenidge and McClean (2000), Donnay and Degryse (2001), De Bondt (2002), and Burgstaller (2003). The literature largely uses monthly data, and estimation is predominantly by single-equation cointegration and error correction modelling, but sometimes by estimating a vector autoregression (VAR). What follows this introduction is an elaboration of the cited literature. Unless otherwise indicated, the estimation method adopted is single equation cointegration and error correction modelling.

### 4.2.2 The Empirical Literature

Using monthly data for 31 developed and developing countries, Cottarelli and Kourelis (1994) estimate a distributed lag model. They provide one of the first comprehensive empirical studies on policy interest rate pass-through to retail bank lending:

$$i_t = \delta + \Sigma^{m}_{j=1}\beta_j\, i_{t-j} + \Sigma^{n}_{k=0}\, \alpha_k m_{t-k} + \Sigma^{p}_{l=0}\, \gamma_t\, \Delta MPR_t \qquad (4.7)$$

where $i$ represents the retail bank lending rate, $m$ is the money market interest rate, and $MPR$, the monetary policy interest rate.

They find important differences in the impact coefficients across countries. While the impact multiplier is fairly high for some countries, it is low, even zero in others. Iceland, Israel, the Netherlands, and the UK showed the highest pass-through, of more than 50 per cent, while Belgium, Finland, and Italy showed the least pass-through. The study also finds differences in the pass-through amongst countries persisting six months after changes in the money market rate. The long-run coefficients, however, tended to one for most countries. Next, the authors sought to explain cross-country differences. They did this by correlating the different coefficients with explanatory variables that could explain the differences. Their main finding was that the impact coefficient is highly correlated with the structure of the financial sector, particularly: the state of development of the sector, the extent of competition, constraints on capital movements, and the ownership structure of banks. Specifically, the authors find that the lending rate is more flexible when barriers to entry to the banking industry are low, the share of private ownership in the banking system is high, there are no constraints to international capital movement, and markets for negotiable short-term instruments exist. The research also finds that movements in the administered monetary policy rate speed up adjustments in lending rates; i.e. the stickiness of commercial bank interest rates is reduced by movements in the policy interest rate.

Investigating the relationship between short-term commercial bank lending rates and the policy and money market interest rates in twelve industrial countries[26] over the period 1984 to mid-1994, Borio and Fritz (1995) find that policy interest rates are significant determinants of commercial bank lending rates in the short and long run for ten of the twelve countries. For the remaining two countries (Sweden and the USA), the money market rate is the more significant rate. The research also finds that by the end of three months, the lending rate responded fully to the change in the policy interest rate in Belgium, Canada, the Netherlands and the UK, with the full adjustment observed in the first month for the Netherlands and the UK. For Australia and the USA, the pass-through is found to be between 70 and 80 per cent in the first quarter. For Japan, France, Germany, Italy, Spain, and Sweden, on the other hand, the adjustment is slower, ranging between 20 and 70 per cent within the first quarter.

[26] These countries are Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, the UK, and the USA.

In the long run, however, the authors find that the pass-through is homogenous and closer to one (the coefficient ranging between 0.8 and 1.1).

Sander and Kleimeier (2002), similarly, study the transmission of central banks policy innovations to commercial bank leading rates[27] using data on twelve European countries. The authors find interest rates in nine of the twelve countries to be cointegrated, confirming the existence of the interest rate channel of monetary policy in these countries. Of the nine countries, the authors find five adjust their lending rates symmetrically and four asymmetrically. Three of the symmetric adjusting countries (Finland, Italy, and Spain) are found to have infinitely long adjustment periods, whilst the remaining two (the UK and Portugal) have six to eight months adjustment period. The countries with asymmetric adjustment (Belgium, Greece, Luxembourg, the Netherlands), were all found to adjust interest rates faster when rates were above the equilibrium level.

Mojon (2000), in the line with Cottarelli and Kourelis (1994), Borio and Fritz (1995), Sander and Kleimeier (2002), find differences in pass-through amongst for six European countries over the period 1979-98; with the policy interest rate measured by the money market rate[28]. He estimates the average pass-through three months after a monetary shock to be 0.35 for Belgium, 0.61 for Germany, 0.15 for Spain, 0.83 for France, 0.67 for Italy, and 0.77 for the Netherlands. Over the sub-period 1992-98, however, the pass-through showed increased convergence to 0.55, 0.54, 0.22, 0.42, 0.58, and 0.86 respectively. Mojon attributes the convergence to increased integration (single monetary policy, money market integration, and development of debt market securities). Mojon also observes that for both deposit and lending rates, the pass–through is negatively affected by volatility in money market rates but positively affected by competition in the financial sector. Donnay and Degryse (2001), similarly, estimate the pass-through from the money market rate (as a proxy for policy interest rates) to the bank lending rates for twelve European countries, using both bivariate and multivariate VAR estimation. The multivariate analysis performed for seven countries involved including the pass-through established from

[27] The twelve countries studied are: Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the UK.
[28] The six countries are Belgium, France, Germany, Italy, the Netherlands, and Spain.

the bivariate analysis in a larger system, to simulate the intermediation role of banks in the transmission of monetary policy to the real economy. The research finds Germany, France, Spain, the Netherlands and Italy having the highest pass-through. In contrast, Belgium, Ireland and Portugal had the least pass-through. From the simulation, the authors find that the role of the banking sector in the real economy reflects the magnitudes of pass-through found from the bivariate analysis.

Using error correction and VAR models, De Bondt (2002) examines the pass-through from market to retail bank interest rates (deposit and lending rates) in the euro area. Four main findings, which follow those of the previously reviewed research, emerge from the study. First, is the existence of cointegration between retail bank and market interest rates. Second, the lack of complete pass-through of market interest rates to retail bank interest rates in the short run: the highest pass-through in a month being 50 per cent. Third, is a higher pass-through in the long-run with the pass-through to lending rates reaching 100 per cent. Fourth, is a faster interest rate pass-through since the introduction of the euro.

There are also country-specific studies of the monetary transmission mechanism. Following Cottarelli and Kourelis (1994), Cottarelli *et al.* (1995) explore the transmission of the policy interest rate to a group of 63 banks operating in locally different financial environments in Italy. The authors work with monthly data, and find that high bank interest rate stickiness is explained by constraints to competition in the banking and financial system. In accordance with this, the authors find that the financial liberalisation process of the early 1990s led to a reduction in interest rate stickiness and to a faster transmission of monetary policy; further, banks that operate in markets that are more competitive tend to translate movements in money market rates to lending rates faster.

Mester and Saunders (1995) study prime rate changes in the USA using weekly data from May 1977 to December 1978. Assuming that banks would change the prime rate when desirable[29], with a log-likelihood model where the probability of prime

[29] Desirability is defined here to be the situation where the optimal prime rate so differs from the existing rate that revenues accruing from the change exceed the costs of the change.

rate change is a function of adjustment costs and exogenous variables[30], they find that adjustment costs have a significant negative effect on the probability of a rate change. Also, the authors find that changes in the exogenous variable trigger a significantly larger probability of a prime rate increase than a decrease.

Heffernan (1996) also considers the dynamics of UK retail deposit and loan rate responses to changes in the bank's base rate, for four banking products from several banks and building societies over 1986-93. Across all banks and products, the study finds that the percentage error correction within a month of the base rate change is 36.48 per cent. The corresponding product error correction averages are: personal loans, 29.8%; chequeing, 37.3%; saving, 38.1%; and mortgage accounts, 40.8%. The study also finds that with the exception of mortgages, there are wide variations in the percentage error correction within a product category by individual banks and building societies. On the long-run coefficient, the research finds them significantly less than unity for chequeing, savings, and personal loans accounts for both banks and building societies. For mortgage accounts, on the other hand, it is unity.

Using single equation cointegration and VAR techniques over 1995-2000, Burgstaller (2003) studies the transmission of the policy interest rate to bank lending rates in Austria. He finds sluggishness and asymmetry in the lending rate response to changes in the policy rate. The maximum instantaneous lending rate adjustment to increases in the policy is found to be 32 per cent, and after three months 62 per cent. Following a reduction on the other hand, the accumulated lending-rate adjustment after three months is comparatively lower. With the establishment of EMU, however, the author finds a decline in asymmetry, i.e. lending rates fell faster following decreases in the policy rate but rose slower with rising policy rates.

Greenidge and McClean (2000) and Scholnick (1996) extend this literature to developing countries. Greenidge and McClean (2000) study the impact of regulatory measures on commercial bank interest rates in Barbados. A 13-equation system including five policy variables is estimated iteratively using a seemingly unrelated regression procedure. The data set consists of monthly observations from six

[30] The exogenous variables considered are cost of funds, inflation, loan demand, and size of the last prime rate change.

commercial banks from 1976-1996. A key finding is the unresponsiveness of commercial bank loan rates to the central bank policy interest rate. The authors attribute this result to the minimal patronage of the central bank's rediscount window, making the central bank interest rate "inconsequential" to the banks.

Using Singapore and Malaysian data, Scholnick (1996) examines whether there are long-run relationships and asymmetries in the retail interest rate response to increasing and decreasing policy interest rates. Scholnick finds that retail and policy interest rates in Malaysia and Singapore have a long-run relationship, and deposit rates exhibit asymmetry - they are more rigid when they are below their equilibrium than when they are above it. Furthermore, Scholnick finds that, though administered, Malaysian lending rates exhibit asymmetry. The authorities tend to keep the rate above its equilibrium in the short run, and adjust it more when below equilibrium.

Disyatat and Vongsinsirikul (2003), in their study of the monetary transmission mechanism in Thailand, examine the degree of pass-through from money market rates to retail rates, attempt to quantify the lags associated with monetary policy shocks, and investigate the channels through which these shocks are propagated. The empirical results point to a transmission mechanism in which investment is particularly sensitive to monetary shocks and banks act as an important conduit for monetary policy to real activity. They also suggest, however, that problems in the corporate and banking sectors may have undermined the monetary transmission mechanism over the last few years.

Also Sander and Kleimeier (2006) investigate the interest rate pass-through in the four Common Monetary Area (CMA) countries of the South African Customs Union (SACU). They employ an empirical pass-through model that allows for thresholds, asymmetric adjustment, and structural changes. They show that CMA bank lending markets exhibit quite some degree of homogenisation as the pass-through is often fast and complete. Deposit markets are somewhat more heterogeneous, showing differing degrees of interest rate stickiness and asymmetric adjustment. Policy-makers should therefore be concerned about imperfect competition which may be at the heart of the remaining cross-country differences in monetary transmission in the CMA.

### 4.2.3 Summary

Economic theory holds that monetary policy should have its strongest effect on short-term commercial bank interest rates, particularly the lending rate. In fact the use of the policy interest rate to influence commercial bank retail interest rates and, in turn, the spending behaviour of economic agents is the central tenet in the conduct of monetary policy. The empirical literature has sought to investigate the responsiveness of commercial bank lending rates to changes in the policy interest rate and has found a sluggish response. However in the long run, for many countries, there is full or near-full transmission of policy interest rate changes to the lending rate.

The literature largely uses monthly data, and estimation is predominantly by single-equation cointegration and error correction modelling but sometimes by estimating a vector autoregression (VAR).

Following empirical literature, this thesis analyses monetary policy effectiveness, measured by the responsiveness of commercial bank savings rate changes to policy interest rate. It uses monthly data and employs three techniques – graphical analysis, the PSS *modified* single equation cointegration and error correction method, and bivariate VAR/VECM model.

The survey of the empirical literature also revealed the limited extension of such analysis to developing-country data. Thus, the estimations in Chapter 6 of the responsiveness of the commercial bank retail interest rate to changes in the policy interest rate in Ghana will broaden this literature. Following this section, the theory and literature on the monetary transmission mechanism is examined.

## 4.3 The Transmission Mechanism of Monetary Policy

### 4.3.1 Introduction

This section considers some of the theory and empirical evidence on the fuller transmission of monetary policy, following a presentation of empirical evidence on the responsiveness of commercial bank retail interest rates to changes in monetary policy - the initial phase of the monetary transmission mechanism.

### 4.3.2 The Channels of Monetary Policy Transmission

Central banks use their leverage over short-term interest rates to influence the cost of capital and consequently spending, aggregate output, and employment, according to conventional textbook views on how monetary policy works. The mechanics of this channel are that a contraction of monetary policy raises short-term nominal interest rates and then, given stickiness in prices and rational expectations, the real long-term interest rate increases, at least for a while. Higher real interest rates lead to a fall in investment and spending on consumer durable goods, and hence in output.

The traditional approach, "the money view", is based on the Keynesian IS-LM model. According to this view, monetary policy affects the real economy through changes in interest rates. This essentially works through the liability side of the banking sector's balance sheet. This is because, according to the view, there are only two financial assets, money and bonds, where the latter represents the whole capital market. Moreover, the assumption of perfect financial markets means that there is no place for financial intermediaries. Since banks do not play any essential role, the only relevant transmission variable is the capital market interest rate. The basic mechanism is that a monetary tightening will lead to excess demand for money balances, inducing action to substitute money for bonds, which in turn bids up nominal capital market interest rates. Subsequently, these translate into increases in real interest rates, because of the assumption of imperfect price adjustments. The increase in the cost of capital in turn discourages investment and consumption. Schematically,

$$M \downarrow \Rightarrow i \uparrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

Where ($M \downarrow$) indicates monetary tightening leading to a rise in real interest rates ($i \uparrow$), which in turn raises the cost of capital and thus discourages both business and consumer spending, causing a decline in investment ($I \downarrow$), thereby leading to a decline in aggregate demand and a fall in output (Taylor, 1995; Mishkin, 1995). Since the interest rate is the only transmission variable, this channel is labelled the interest rate channel.

In the Ghanaian context, changes in the central bank's prime rate influence the interest rates of domestic commercial banks, which adjust their retail rates but not necessarily by the same amount. According to economic theory, it is generally expected that a change in the discount rate would lead to a change in retail rates of commercial banks almost instantaneously and lead further to a change in the overall liquidity position within the financial system.

As liquidity within the financial markets is drained by a decrease in the prime rate followed by market interest rates, firms and individuals respond by changing their spending and investment behaviour, which eventually affects inflation. This would suggest that commercial banks or financial intermediaries play only a passive role, responding to the demand for credit resulting from the changes in interest rates.

In countries with relatively high inflation such as Ghana, the interest rate channel is weakened by the volatility of inflation. In other words, when inflation is high, a tight monetary policy does not necessarily imply a high real interest rate, since the volatility premium would be equally high. Accordingly if the inflation rate were low, implying less volatility, this would enhance the objective of the interest rate channel as a transmission mechanism of monetary policy.

The increased interdependence of world economies and advances in financial technology have broadened the menu of financial market prices through which monetary impulses are propagated through the economy. These other asset prices include the exchange rate, real-estate and equity prices. The representation of the monetary transmission mechanism is the traditional Keynesian paradigm for analysing monetary policy effects on the economy. A key feature of this channel and also the primary source of criticism is its focus on one relative price, the interest rate

- the issue being what the right interest rate is for investments (e.g. Eichenbaum, 1994). Thus, rather than focus on one interest rate, monetarists have argued, it is better to look at how monetary policy affects the universe of relative asset prices and wealth. Although they do not commit to specific transmission mechanisms because they see the mechanism as changing over the business cycle, monetarists emphasise two channels: Tobin's *q* theory of investments and wealth effects of consumption (Mishkin, 1995).

Tobin's *q* theory provides a mechanism through which monetary policy affects the economy through changes in equity value. Under Tobin's q theory, monetary policy affects the economy through its effects on the valuation of equities. If q, defined as the market value of firms divided by the replacement cost of capital, is high, the value of the firm is high compared to the replacement cost of capital, implying that new plant and capital equipment is cheap relative to the market value of business firms. Firms will issue equity and get a high price for it relative to the cost of the plant and equipment they are buying. Firms will therefore buy a lot of new investment goods with a small issue of equity. A monetary tightening would lower the price of equity by reducing the amount of money in public hands. Monetarists argue that when money supply falls, economic agents respond by reducing spending, including in the stock market. If demand for equities falls, their price relative to the replacement cost of capital reduces. This lowers the q, investment spending, and output. Thus, lower equity prices ($P_e \downarrow$) will lead to a fall in q ($q \downarrow$), which will in turn lower investment spending ($I \downarrow$) and output. Schematically;

$$M \downarrow \Rightarrow P_e \downarrow \Rightarrow q \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

Mishkin (1995) argues that the traditional Keynesian interest rate channel leads to similar conclusions because the higher interest rates that come from a contractionary monetary policy makes bonds more attractive relative to equities, and lowers equity prices and hence investment and output. Thus, the argument is that even if bank loan rates react little to policy tightening, monetary policy can still affect Tobin's q and hence investment spending.

Closely related to Tobin's *q* is the wealth effect on consumption, advocated by Modigliani (1971). Modigliani's life cycle hypothesis states that consumption is determined by the life-time resources of consumers; and an important component of consumers' life-time resources is their financial wealth, a major component of which is stocks. The consumption-wealth channel of monetary policy emanating from this hypothesis is that a contractionary monetary policy lowers stock prices, reduces household wealth and consumer spending and then output.

When monetary policy is relaxed, agents have more disposable income for spending. One possible place to spend this money is stock markets. Higher spending in stock markets leads to a rise in stock prices. The ultimate effect would be increased wealth of households through increase property and equity prices and therefore an improvement in the lifetime resources and eventually consumption.

Metzler (1995) argued that the asset price effect extends beyond those operating through interest rates, exchange rates and equity prices. He cited an example of the Japanese experience in the 1980s where monetary policy had an important impact on the economy through its impact on land and property values. This can be illustrated by the fact that monetary policy tightening can lead to a decline in land and property values, which in turn leads to a decline in household wealth and thus a decline in consumption and aggregate output.

A second criticism of the traditional interest rate channel is the difficulty in identifying statistically significant effects of interest rates through the cost of capital (e.g. Bernanke and Gertler, 1995). This has led to the propagation of another channel of monetary policy transmission that is distinguished by its emphasis on the role of credit. Advocates of this channel attribute its strengths to agency problems in the credit market.

In contrast with the money view, the credit view assumes that capital markets are imperfect and segmented. It emphasises asymmetric information as the main cause of credit market imperfections. Moreover, while the money view focuses on the aggregate level, the credit view allows for the distributional consequences of monetary policy to be assessed. This view highlights heterogeneity among borrowers and stresses that it may be more difficult or expensive for some borrowers to obtain external funds than others. For example, households and small firms cannot readily obtain funds from capital markets and thus have to rely on intermediated loans and internal finance. Therefore, unlike the money view, the credit view admits the role of financial intermediaries (banks).

According to Bernanke and Gertler (1995), imperfect information or costly enforcement of contracts may interfere with the smooth functioning of financial markets, thereby creating a wedge between the cost of funds raised externally (borrowed) and the opportunity cost of internal funds. They argue that this wedge, which they call the *external finance premium*, is a reflection of the deadweight loss associated with the principal-agent problem that normally exists between borrowers and lenders. This view stresses that monetary policy changes that disrupt the flow of bank credit will affect the external finance premium and thus potentially have non-negligible real effects. The size of an external finance premium reflects imperfections in credit markets that drive a wedge between the expected return received by lenders and the costs faced by potential borrowers. Monetary policy, which alters the interest rate, tends to affect the external finance premium in the same direction. Thus, the direct effects of monetary policy on the interest rate are amplified by changes in the external finance premium. This complementary movement in the external finance premium may help explain the strength, timing and composition of the monetary policy effects better than reference to interest rates alone.

The credit channel is usually described as working through two main routes: bank lending and the balance sheet. The bank lending channel follows directly from the fact that banks have a specific function as financial intermediaries. This is because banks can specialise in acquiring information about default risks and can thus easily distinguish between good and bad borrowers. They can therefore devise non-price mechanisms, such as credit rationing to screen out untrustworthy borrowers (Stiglitz and Weiss, 1981). Therefore, banks are considered to be particularly well-suited to dealing with certain types of borrowers, especially small firms and individual households who, because of the problems of asymmetric information, cannot easily access non-bank forms of credit. An important implication of this is that any kind of disruption in the flow of credit potentially has real effects. For instance, if banks cannot substitute deposits with other sources of funds, then a contractionary monetary policy that decreases bank reserves and bank deposits (D) is likely to reduce the quantity of loans (L) that banks can supply. Thus a monetary policy that operates through a bank lending channel can be represented as:

$$M \downarrow \Rightarrow D \downarrow \Rightarrow L \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

The question though is whether monetary policy can significantly affect the supply (or relative pricing) of loans. Bernanke and Blinder (1988) develop a model that suggests open market sales by the central bank can drain reserves and hence deposits from the banking system and in that way limit the supply of bank loans, by reducing banks' access to loanable funds. According to their model, there are three necessary conditions that must hold for the lending channel of monetary policy transmission to work:

- Commercial bank loans are important and nearly the only sources of funds for companies, and bonds and loans must be imperfect substitutes. In this way firms would be unable to offset the decline in the supply of loans by borrowing directly from the market.
- The Central Bank must be able to play the role of a lender of last resort by being able to influence the liquidity of financial intermediaries/commercial banks (Kashyap et al 1993, 1994) and Cecchetti (1995).
- There should be some price rigidities (slow adjustment of prices but not full) so that monetary policy actions are not neutral. If prices adjust smoothly, this will mean that changes in nominal reserves will be followed by changes in prices of the same magnitude which will leave bank balances and company balance sheets unchanged and ultimately monetary policy will have no real effects.

However, as Bernanke and Blinder (1992) point out, this depends on the institutional setting in the financial sector. The assumption of the Bernanke-Blinder model, that banks cannot easily replace lost deposits with other sources of funds, might not be valid because banks can issue certificates of deposit (CDs) or new equity (Romer and Romer, 1990). However, the proponents of the bank lending channel argue that its existence does not require banks to be totally incapable of replacing lost deposits (Bernanke and Gertler, 1995). As long as banks do not face perfectly elastic demand for open market securities, an increased reliance on the securities would increase banks' relative cost of funds. This would shift the supply of loans inward, thereby squeezing out bank-dependent borrowers.

The importance of the bank lending channel of monetary policy has, however, been questioned. Edwards and Mishkin (1995), for example, argue that with the financial innovations of recent decades, banks play a less important role in the credit market than they did in earlier decades.

The theoretical proposition of the balance sheet channel is that the external finance premium facing a borrower should depend on the borrower's financial position or net worth (Bernanke and Gertler, 1995). Firms with higher net worth, which can be derived from their balance sheets, are likely to face a lower external finance premium. Since borrowers' financial positions affect the external finance premium and thus the overall terms of credit that they face, fluctuations in the quality of borrowers' balance sheets similarly should affect their investment and spending decisions.

A balance sheet channel of monetary policy arises because a monetary tightening will not only affect the interest rate, but will also lower the net worth of borrowers. A tight monetary policy therefore directly weakens borrowers' balance sheets in at least two ways. First, rising interest rates directly increase interest expenses, reducing net cash flows and weakening the borrower's financial position. Second, rising interest rates are also typically associated with declining asset prices, which among other things shrink the value of the borrower's collateral. The indirect effect of tight monetary policy on net cash flows and collateral values is a deterioration in consumer expenditure. The firm's revenues will decline while its various fixed or quasi-fixed costs do not adjust in the short run. The financing gap, therefore, erodes the firm's net worth and creditworthiness over time. Lower net worth implies that borrowers, in effect, have less collateral for their loans and are therefore of higher risk. This raises the adverse selection problem as banks cannot distinguish borrowers' risk types. Lower net worth of firms may also increase the moral hazard problem because it means that owners' equity stakes in businesses fall and thus give them more incentive to engage in risky investment projects. In response to the adverse selection and moral hazard problems, banks may reduce the amount of loans extended. Thus in addition to a cost effect due to the increased interest rate, the availability of funds may be reduced, thus leading to a decline in investment and ultimately output. Schematically:

$$M \downarrow \Rightarrow P_e \downarrow \Rightarrow \textit{adverse selection} \uparrow \,\&\, \textit{moral hazard} \uparrow \Rightarrow \textit{lending} \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

Similarly, a monetary tightening that raises interest rates may weaken firms' balance sheets by raising interest expenses on their outstanding short-term debt, thus reducing their cash flows. A fall in cash flows implies a decline in net worth. The transmission schema is similar to the one above.

Gertler and Gilchrist (1993, 1994) find that the effect of a cash flow squeeze on economic behaviour depends largely on firms' ability to smooth the drop in cash flows by borrowing. Large firms are at least temporarily able to maintain their levels of production and employment in the face of higher interest costs and declining revenues through other sources of short-term credit, such as commercial paper. The inventories of large firms grow following a tightening of monetary policy. However, small firms, who have more limited access to short-term credit markets, tend to reduce inventories by cutting work-hours and production.

While the credit channel is usually presented as an alternative to the traditional interest rate channel, Bernanke and Gertler (1995) argue otherwise. They contend that this channel is not a distinct freestanding alternative to the traditional monetary transmission mechanism but, rather, a set of factors that propagate conventional interest rate effects. They describe the credit channel as one that amplifies the direct effects of monetary policy on interest rates through endogenous increases in the external finance premium following a rise in the policy interest rate[31] . This effect of

[31] Bernanke and Gertler (1995) define the external finance premium as the difference in cost between funds raised externally (by issuing equity or debt) and funds generated internally (by retaining earnings). They argue that the size of the premium reflects imperfections in the credit market that drive a wedge between the expected return received by lenders and cost financed by potential borrowers.

policy on the external finance premium accentuates the impact of monetary policy on the cost of borrowing and consequently on spending.

### 4.3.3 Motivation for the Credit Channel

The credit view on the monetary transmission mechanism is based on the notion that the link between monetary policy and economic activity is based on its power to influence changes in banks' assets (total credit extension), rather than in banks' liabilities (money balances in the economy). This is precisely contrary to the money view. The credit view is further supported by the following puzzles not properly explained by any other channels: (e.g. Bernanke and Gertler, 1995):

1. The fact that investment expenditure responds more strongly to short term interest rates rather than of long-term interest rates, as implied by the traditional interest rate channel.
2. The fact that internal funds of firms determine their investment decisions and capacity more than fluctuations in market interest rates.

If the credit view is important, the next question is to explain what implications it could hold for the formulation and understanding of monetary policy. First, if the credit view is correct, it implies that monetary policy can affect the real economy without much variation in the open-market interest rate. It calls for focusing on alternative indicators (such as total bank credit extension) in trying to understand the stance of monetary policy at a particular point in time. More importantly, if there was more information available about the particular transmission mechanism at play, Central Bankers would be able to design and adopt the correct targets and thereby improve on the choice of targets.

Second, the view can explain how monetary contraction influences investment and inventory behaviour. This is because empirical work on the interest rate channel fails to explain the responsiveness of inventories to interest rate changes and hence concludes that monetary policy cannot have a direct influence on inventory (Bernanke and Gertler 1995). According to the credit view, firms' investment decisions are determined by the availability of internal funds. In addition, understanding the credit channel will offer insights on how innovations in financial institutions might affect the potency of monetary policy.

Furthermore, the credit channel can explain the distributional effects of monetary policy on both lenders and borrowers, while the conventional money view cannot. Specifically, the cost of tight monetary policy might affect smaller firms/borrowers who might not have easy access to public capital markets, more than it affects borrowers who have access to these markets.

Finally, the credit view also implies that the impact of monetary policy on economic activity is not always the same, as it depends on the access of borrowers to capital markets. Thus, it is sensitive to the state of firms' balance sheets and health of the banking sector and has obvious implications for the ability of monetary policy to offset particular sorts of adverse shocks.

In addition to the interest rate, Tobin's $q$, wealth, and credit channels of monetary policy, is the exchange rate channel whose effect is particularly important for small open economies with flexible exchange rate regimes, such as Ghana. The exchange rate effect is primarily through net exports and balance sheets as follows. An expansionary monetary policy which depreciates the exchange rate boosts net exports and hence aggregate spending. Currency depreciation could also affect spending through the balance-sheet effect if households and firms hold significant foreign currency debt. Unless such debts are fully offset by foreign currency assets, the depreciation will increase firms' debt burden, and reduce net worth, lending, investment, aggregate demand and hence economic activity. Thus, the balance-sheet effect of depreciation implies that expansionary monetary policy could actually be contractionary in emerging/developing economies.

With the growing integration of the world economy, monetary authorities need to pay close attention to monetary policy transmission operating through the exchange rate effects on net exports. In small open developing economies with flexible exchange rates, like Ghana, the exchange rate channel plays a particularly important role because, unlike the other channels discussed above, it affects not only aggregate demand but aggregate supply as well. A policy-induced increase in the domestic real interest rate will make domestic assets more attractive relative to assets denominated in foreign currencies. In the presence of a high degree of international financial capital mobility across borders, there will then be net capital inflows. Under a flexible exchange rate regime this leads to an appreciation of the domestic currency ($E \downarrow$)[32], which in turn: (1) affects the domestic price level directly by lowering the domestic currency price of imports. According to Walsh (1998) this exchange-rate-to-inflation channel speeds up the impact of monetary policy on domestic inflation because exchange rates respond quickly to interest-rate changes; (2) induces substitution effects between domestic and foreign goods, thereby influencing aggregate demand and supply.

### 4.3.4 Summary

The monetary transmission mechanism is concerned with the endogenous behaviour of macroeconomic variables in response to exogenous policy impulses (Dale and Haldane, 1995). Theory on the monetary transmission mechanism can be divided into two broad views, depending on the assumptions made about the nature of financial markets. One view, the money view, is based on the assumptions that financial markets are homogenous and perfect. Under these assumptions, monetary disturbances have real effects only if there are nominal rigidities. The other view – the credit view – is premised on the assumption that capital markets are imperfect

In summary, the money view predicts that a monetary tightening would lead to the following chain of events. First interest rates would rise and monetary aggregates fall. Then output and price levels would decline in the short-to-medium term. This arises because an increase in the interest rate leads to declines in interest-sensitive components (consumption and investment) of aggregate demand – *the interest rate channel*. Variations in interest rates also affect the prices of other assets – *equity and the exchange rate*. A policy induced increase in interest rates lowers equity prices, which may in turn affect both investments negatively by raising the cost of capital and consumption by making consumers poorer. As for the exchange rate, an unexpected increase in domestic policy rate, all else being equal, would lead to an appreciation of the domestic currency on impact. The appreciation of the domestic

[32] The exchange rate, E, is measured as units of domestic currency per unit of foreign currency.

currency would lower the relative cost of imports and raise that of exports. The direct effect of this would be to lower inflation, while the indirect effect comes through its impact on net exports.

In the credit view the contractionary monetary impulses are transmitted to a large extent through declines in bank lending. One way through which monetary tightening depresses activity is by squeezing bank reserves and hence reducing bank deposits. The decline in bank deposits implies a fall in the supply of loanable funds, thus leading to a reduction in the credit extended by those banks that do not have alternative sources of funds. The fall in credit would limit the activities of bank-dependent firms, which would in turn limit economic activity. Policy-induced increases in interest rates may also reduce the value of collateral offered by potential borrowers and thus increase the adverse selection and moral hazard problems, leading banks to reduce the amount of credit they extend. Thus, according to the credit view, contractionary monetary policy depresses economic activity through its effect on bank-dependent borrowers. The operation of this channel gives rise to a potentially differential impact of monetary policy where some sectors bear a disproportionate share of the policy-induced changes. However, the credit channel is not regarded as a free standing alternative to the money view, but as "a set of factors that amplify and propagate conventional interest rate effects" (Bernanke and Gertler, 1995, pp. 28).

Although commonly presented as four distinct channels of policy transmission, the discussion suggests that the exchange rate, credit, Tobin's *q*, and wealth channels all amplify the conventional interest rate effects. Thus, rather than be seen as independent and free-standing channels of monetary policy transmission, they must be rightfully viewed as enhancing the traditional interest rate channel. The exchange rate is particularly important for a small open developing economy like Ghana. Chapter 7 adopts this approach in analysing the monetary transmission mechanism. This thesis now provides some empirical evidence on the monetary transmission mechanism.

#### 4.3.5 The Empirical Literature

Given that comprehensive surveys of this literature already exist, e.g. Christiano *et al.* (1999), this section aims to present only a sample of the literature to indicate: (i) the preponderant estimation technique adopted for such analysis - VARs, (ii) variables that are included in the VARs, (iii) identification assumptions, and (iv) the dynamic effects of monetary policy shocks found to serve as reference for comparing our results. The literature surveyed here includes Romer and Romer (1989), Bernanke and Blinder (1992), Dale and Haldane (1995), and Christiano *et al*. (1997). The near consensus of the literature is that after a contractionary monetary policy shock, the short term interest rate rises and after varied lags, monetary aggregates, aggregate output, employment, and profits fall. The aggregate price level, distinctly, responds very slowly, usually rising for up to two years before falling. Various measures of wages also fall, albeit by modest amounts.

The empirical literature on monetary policy transmission is large, much of it using US data. Using post-war US data, Romer and Romer (1989) test whether there are any identifiable relationships between monetary contractions not caused by output disturbances and real output. For this, they estimate two forecasting models for two measures of real activity: industrial production index (IPI) and unemployment. The models include monthly dummies and dummies for periods of contractionary monetary shocks. Romer and Romer find that following monetary contractions, real activity, after a six-month lag during which it rises, then falls: the maximum impact occurs 33 months after the shock. At this time, when measured by IPI, real activity is approximately 12 per cent below the pre-shock level; and when measured by unemployment, unemployment is 2 per cent above the base level. For both measures of activity, the effect of the shock does not dissipate over the 36-month forecast horizon.

Bernanke and Blinder (1992) investigate the effect of monetary policy on the economy and the channel of transmission with monthly US data over 1959-78. Their measure of monetary policy is the Federal Funds Rate (FFR). For this purpose, a VAR that includes the FFR, unemployment rate, log of the CPI, and log levels of three bank balance-sheet variables (deposits, securities, and loans) in that order is estimated. From the estimated impulse response functions, Bernanke and Blinder find that a positive innovation in the FFR reduces the volume of deposits held by depository institutions immediately, and maximally after twelve months. Although there is some recovery, the dip in deposits appears to be permanent. The authors find that bank assets fall along with deposits but the pattern of fall varies amongst the different assets. In the first six months after a policy shock, the fall in assets is concentrated almost entirely in securities; loans hardly move. Shortly after, however, security holdings begin to be rebuilt, while loans start to fall. After two years, securities holdings return almost to their original value and the entire decline in deposits is reflected in loans.

Bernanke and Blinder (1992) also observe that there is no effect on unemployment in the first eight months after the innovation to the policy variable. Unemployment from the ninth month, however, begins to rise, building gradually to a peak in about two years, before declining back to zero. The authors also find good correspondence of the estimated timing of the unemployment response and loan response. They give two interpretations to the coincidence of timing. One, it signifies consistency with the view that bank loans are an important component of the monetary transmission mechanism, even though loans do not lead real variables. Two, monetary policy works through the conventional money demand mechanism and the observed behaviour of loans reflects a purely passive response to a falling demand for credit.

Using monthly UK data from 1974:6 to 1992:10, Dale and Haldane (1995) analyse the effects of policy shocks on asset prices, bank balance sheet variables, GDP, and prices. The measure of monetary policy is the Bank of England's stop rate: the minimum rate at which the Bank supplies marginal funds to the discount market. The variables in the VAR are ordered as follows: policy interest rate, exchange rate, stock market prices, lending, deposits, real economic activity, and price. Their estimated impulse responses showed that following a rise in the interest rate, the exchange rate appreciates up to the third year; share price declines and remains low for four years; lending, after a 15-month lag, falls and stays depressed over the remaining months of the five-year horizon. Deposits fall, but only after two years. The shock also depresses real economic activity and inflation but these effects are seen over the medium term. For real economic activity, the lag is six months and the maximum dip occurs between months 18 and 24, after which the effect of the shock moderates. For prices, the lag or the period of puzzle is in the initial three and half years, after which it falls in the remaining 18-month forecast period.

The effects of a contractionary shock to monetary policy (measured by FFR) on measures of real wages and profits in the US are analysed by Christiano *et al*. (henceforth CEE, 1997). CEE adopt both non-recursive and recursive identification assumptions, where the policy interest rate is ordered last under the recursive assumption. Regarding the general effects of a contractionary monetary policy shock, under both identification assumptions the authors find, initially, a persistent rise in the FFR, and persistent drops in nonborrowed reserves and the growth rates of broad money. After a quarter, real GDP declines. The shock also generates a persistent decline in the index of commodity prices. Furthermore, the authors find the GDP deflator unresponsive to the shock for about eighteen months before it declines, and monetary policy not to have an effect on real balances in the long run.

CEE also analyse the effects of a contractionary monetary policy shock on five measures of real wages (including economy-wide wages, private sector non-agricultural sector wages, and manufacturing wages) and find that in all cases real wages decline after a contractionary FFR shock, albeit by modest amounts. Manufacturing real wages fall more sharply than the economy-wide measures. Within manufacturing, wages fall more rapidly in durable goods industries relative to nondurable goods industries. These findings lead CEE to doubt the finding from models of the monetary transmission mechanism that find nominal wage stickiness, predicting a real wage rise, not a fall after a contractionary monetary policy shock.

To study the response of real profits to a contractionary monetary policy shock, CEE consider measures of aggregate profits in five sectors of the US economy: manufacturing, durables, nondurables, retail, and transportation and utilities. In three sectors, they find that a contractionary monetary policy shock leads to sharp persistent drops in profits. For the nondurables, and transport and utility sectors where profits rise, CEE find the rise insignificant.

Examining the monetary transmission mechanism in Japan with VAR models Morsink and Bayoumi (2001) employ quarterly data. The measure of monetary policy stance is the uncollaterised overnight call rate - the operating target for monetary policy. Morsink and Bayoumi first estimate a four-variable VAR with the ordering as: economic activity (real private demand), prices, interest rates, and broad money[33]. Four main results emanate. First, interest rate shocks appear to depress economic activity significantly, after a six-quarter period of puzzle. Second, broad money shocks have significant effects on output, even with interest rates in the model. This they interpret as being consistent with the idea that non-policy monetary shocks are important for determining economic activity. Third, much of the effect of interest rate shocks on output is transmitted through broad money. Finally, there is a price puzzle in the initial quarters. Next, Morsink and Bayoumi (2001) extend the VAR in different directions to examine alternative aspects of the monetary transmission mechanism. Extending the base VAR by base money, with the variable ordered after the interest rate but before broad money; the authors find that base money has no significant impact on output.

The authors then disaggregate private demand into private consumption, business consumption, housing investment, and net exports and include one of these components at a time, plus the rest of private demand in the VAR. This is to examine the sensitivity of the different components of private demand to monetary shocks. For each component added, the VAR was ordered as follows: total private demand less the component of interest, the demand component of interest, prices, the overnight call rate, and broad money. They find that monetary policy operates on the real economy largely through its impact on business investment, with the maximum impact of over 0.2 percentage points fall occurring after two and a half years.

They extend the VAR to include the main components of private sector funding-bank loans, public loans, and money raised in the securities market. Securities are ordered last to reflect the relative ease with which they can be adjusted, to investigate the role of financial intermediation in the monetary transmission mechanism. The results of the analysis point to a transmission mechanism that is dominated by banks, in which lending is both an important independent source of shocks and important conduit for the transmission of interest rate and broad money shocks to real activity. They find that after two years, about two-thirds of the direct impact of a change in the overnight call rate on private demand comes through bank loans and, of this change, about two-thirds comes through business investments. They also find that

[33] Economic activity is measured by real private demand as it is argued that government spending is exogenous. Private demand and real broad money are scaled by potential output, and the price level is the natural logarithm of the CPI.

innovations to bank loans elicit no significant response from securities markets or public loans, suggesting that there is no effective substitute for bank loans.

Gertler and Gilchrist (1994) also study the relative effects of monetary policy on small and large borrowers using three firm variables: sales, inventories, and short-term debt in a VAR analysis. This is under the assumption that firm size is a reasonable proxy for capital market access. The measures of monetary policy stance are the Romer and Romer (1989) episodes and the FFR. The authors first estimate bivariate VARs for each size class of firms and dummies for tight money. When inventories and short-term debt are used as firm size measures, sales are kept in the regression. This is to investigate if monetary policy has an effect on the two variables independently of their influence on sales. They also estimate a multivariate system that adds macroeconomic variables (real GNP growth and inflation) to each of the three equations. Gertler and Gilchrist find that small firms account for a disproportionate share in the decline in sales following a contractionary monetary policy shock. In addition, they find that small firms' inventories fall immediately after the shock, while those of large firms rise before falling in response to the shock. Based on these results, they conclude that credit market imperfections play an important role in the monetary transmission mechanism.

Bernanke and Gertler (1995) estimate a VAR that contains: real GDP, real GDP deflator, the index of commodity prices[34], and the FFR in that order (the FFR being the measure of policy) to investigate the dynamic responses of the variables to monetary policy shocks using monthly US data for 1965-93. The impulse response functions showed GDP rising in the initial four months after a monetary policy tightening, after which it falls. The fall is to its lowest in the 24$^{th}$ month and the effect of the shock dissipates by the 48$^{th}$ month after the initial shock. Regarding price level, Bernanke and Gertler find it shows a marginal rise above its base for about a year, before beginning to decline (well after the drop in GDP begins). There appear to be long-run effects, as prices appear to have some momentum to fall after the forecast horizon. Finally, the authors observe that the interest rate spike associated with an unanticipated monetary tightening is largely transitory: interest rates return to trend by about the 24$^{th}$ month.

[34] As the exclusion of commodity prices tends to lead to the price puzzle, following Sims (1992), the commodity price index was included in the VAR to capture the future course of inflation.

Bernanke and Gertler (1995) replace real GDP with two of its key components - final demand and inventory investment to investigate in detail the economy's response to a monetary shock. The authors find that final demand drops quickly following an unanticipated tightening of monetary policy. In contrast, inventories build up for a period of several months before beginning to decrease, implying that a fall in real GDP is led by final demand.

Bernanke and Gertler also explore the responses of the components of a further disaggregated GDP to an unanticipated shock in monetary policy. They find that residential investment drops sharply following a monetary tightening and accounts for a large part of the initial fall in the final demand. The next fastest and steepest fall is non-durable consumption, followed by consumer durables. Last to decline is business investment. However, Bernanke and Gertler take issue with the magnitudes and timing of the responses, as well as with the composition of spending effects. First, they argue that relative to small movements in the policy interest rate, the magnitude of response of the economy is large. Second, the components of spending react only when the interest rate is back to trend. Third, the authors argue that because monetary policy has its most direct effect on short-term rates, it would stand to reason that monetary policy would have its most significant influence on assets with shorter lives; but this is not found. Rather, a long-lived asset (residential housing) responds most speedily while another long-lived asset (business structures investments) is not much affected by monetary policy actions. The authors describe these outlined patterns of response as puzzling, but find that introducing the credit channel helps rationalise them.

Eichenbaum and Evans (1995) consider variants of the benchmark FFR and non-borrowed policy measures in which some foreign variables appear in the Federal Reserve's reaction function. Assuming that the Federal Reserve does not respond contemporaneously to movements in the exchange rate, they find that a contractionary shock to US monetary policy leads to: (i) a persistent and significant appreciation in US nominal and real exchange rates, (ii) persistent decreases in the spread between foreign and US interest rates, and (iii) significant and persistent deviations from uncovered interest rate parity in favour of US investments.

Grilli and Roubini (1995), using the Choleski identification to analyse monetary policy in the G-7 countries observe initial home currency depreciation in response to positive home interest rate innovations for every country except the US. Also Sims (1992) finds that for many of the five major industrial countries, positive interest rate innovations are associated with an initial depreciation of the home currency (as well as increases in home prices).

Arnoštová and Hurník (2005) analyse the monetary policy transmission mechanism using VAR models – the most widely used empirical methodology for analysing the transmission mechanism in the Czech economy. Using the VAR methodology, their paper tries to evaluate the effects of an exogenous shock to monetary policy. The first model covers the full data sample from the first quarter of 1994 to the fourth quarter of 2004, while the second one covers the period after the regime change only (1998 to 2004). The reason for estimating two models was a change in the monetary policy regime in the middle of the 1990s. Consequently, the results differ in several respects. However, both models are estimated using the same set of variables, namely, real GDP, the net inflation price index, the commodity price index, the short-term nominal interest rate, the bilateral euro exchange rate, the domestic money stock and foreign real GDP as an exogenous variable. The results show that an unexpected monetary policy tightening leads to a fall in output, whereas prices remain persistent for a certain time. The exchange rate reaction then depends heavily on the data sample used. Although it is clear that due to the rather short time span of the data, the results should be taken with caution, they at least show that the basic framework of how monetary policy affects the economy does not differ significantly either from what would be predicted by the theory or from the results obtained for more developed economies.

Catao et al (2008) lay out a structural model that incorporates key features of monetary transmission in typical emerging-market economies, including a bank-credit channel and the role of external debt accumulation on country risk premia and exchange rate dynamics. They use an SVAR representation of the model to study monetary transmission in Brazil, an emerging inflation targeter. They find that interest rate changes have swifter effects on output and inflation compared to advanced economies and that exchange rate dynamics plays a key role in this connection. Importantly, the results show that the response of inflation to monetary policy shocks has grown stronger and the output-inflation trade-off improved since the introduction of inflation targeting.

Regarding empirical work on the transmission mechanism in African countries, Bleaney and Lisenda (2001) estimate a monetary reaction function for the Bank of Botswana for the period 1991-1999. They find that interest rates react significantly to private sector credit growth and to recent inflation, but not to the real exchange rate or to South African (main trading partner) interest rates. On the transmission of monetary policy, they note that the high correlation (0.958) between the Bank rate and commercial bank lending rates and the significantly negative correlation between growth of bank credit and commercial bank lending rates suggest that channels of monetary transmission work.

Smith and Du Plessis (2001) use a simultaneous equation approach (structural vector auto regression (SVAR)) to identify the policy maker's reaction function in South Africa. They place a number of restrictions on the VAR, taking into account practical policy and institutional changes. A justification for this is that purely statistical techniques used to identify the monetary policy transmission mechanism do not take into account social constraints on monetary economic analysis. Having identified a relationship of the SVAR, an impulse response function is used to trace the effect of each shock in the SVAR over a period. This technique allows for a transformation of the reduced-form VAR into a system of structural equations.

A starting point of the SVAR analysis is the specification of a set of variables of interest to the problem in hand. In this case of monetary policy analysis the list typically includes money supply, one or more interest rate, and real output and aggregate price level.

Smith and Du Plessis (2001) use real short-term domestic interest rate, monetary aggregate, aggregate price level, aggregate output, dollar oil price, international interest rate (US fed rate), and exchange rate. They find that innovation from the policy instrument leads to a reduction in the price level but does not have a significant effect on output. The study further concludes that monetary policy in

South Africa is mainly endogenous. In other words, it responds to developments in the macro economy instead of independently influencing the course and direction of the economy.

Atingi-Ego (2000) finds that the time lag in the transmission of a policy interest rate change to inflation in Uganda is six months - at which point a one percentage point rise in the policy interest rate leads to a one percent fall in inflation. Using South African data, Stals (1995) finds that the time lag in the transmission of changes in the policy interest rate to inflation is four quarters, while Smal and De Jager (2001) estimate it at between four and eight quarters. For the lag in the interest rate impact on the real economy, Smal and De Jager (2001) find this to be between four and six quarters.

Simatele (2004) conducted a similar study for Zambia and found that contractionary monetary policy was followed by a fall in both price and output levels. She also found evidence of the operation of bank lending and the exchange rate channels, with the latter being stronger.

Cheug (2006) examines the impact of a monetary policy shock on output, prices, and the nominal effective exchange rate for Kenya using data covering 1997-2005. Based on techniques commonly used in the vector autoregression literature, his main results suggest that an exogenous increase in the short-term interest rate tends to be followed by a decline in prices and appreciation in the nominal exchange rate, but has an insignificant impact on output. Moreover, the paper finds that variations in the short-term interest rate account for significant fluctuations in the nominal exchange rate and prices, while accounting little for output fluctuations.

## 4.4 Summary

The empirical studies in the literature review show that a contractionary monetary policy shock has a number of effects. First, interest rates initially rise and monetary aggregates initially fall. The initial rise in interest rates is subsequently reversed, probably through deflationary pressure from the monetary contraction. Second, usually up to about six months following the monetary contraction, there is an absence of effect or, more customarily, an initial rise in output (the output puzzle). Output subsequently falls as theory predicts, a fall that remains sustained for about two years. Third, the price level declines in line with theoretical predictions, but only eventually. There is usually an initial rise (the price puzzle) that lasts for up to about two years. Fourth, where a variable that captures future inflation is included in the VAR, the price puzzle is eliminated[35].

It appears final demand absorbs the initial impact of a monetary tightening, falling relatively quickly after a change in policy for the research that disaggregates aggregate demand. This is followed by a reduction in production. The lag in production response implies that inventory stocks rise in the short run. Further disaggregation of demand shows that residential investment depicts the earliest and sharpest decline in final demand, followed by spending on consumer goods.

Given that the size and speed of transmission of monetary policy impulse to these goal and target variables provide information on the effectiveness with which monetary policy influences the variables, and that the empirical literature showed limited extension to African countries, the estimations of the monetary transmission mechanism in Ghana, whilst providing information on the effectiveness of monetary policy, also usefully extends this empirical literature.

The chapter has presented theory and literature that underlies the empirical analysis in the rest of the thesis i.e. the estimation of monetary policy conduct and the investigation of monetary policy effectiveness in Ghana. In presenting the theory and literature on monetary policy rules, Section 4.1 has demonstrated the superiority of monetary policy conducted with feedback rules. Given that the central tenet in

[35] Some research, e.g. Cushman and Zha (1997) argues that the puzzles are usually the result of identification (usually recursive identification) of monetary policy that is invalid. Thus, as a solution to the puzzle, they propose generalised VAR methods in which non-recursive structures are allowed.

monetary policy conduct is the use of the policy interest rate to influence commercial bank interest rates and in turn spending behaviour, the chapter went on to present the literature on the responsiveness of commercial banks retail rates to the policy interest rate in Section 4.2. The literature, using mainly industrialised country data, depicts long-run pass-through of changes in the policy rate to the lending rate of unity. In the short-run, however, there is evidence of sluggishness, albeit of varied degrees. Section 4.3 then presented the theory and the literature on the monetary transmission mechanism more fully, the summary of which is in the preceding sub-section.

Given that the methods of monetary policy conduct in Ghana are in line with those of industrialised countries upon whom the empirical work has concentrated, the empirical analysis that follows in Chapter 5, 6, 7 provide useful extensions to the literature following established theory and techniques, but applied to a small, open developing economy.

# Chapter 5

# Monetary Policy Reaction Functions Estimates

## 5.1 Introduction

This chapter poses and answers two questions. First, how has the central bank in Ghana conducted monetary policy since it adopted market-based instruments? Second, how effective has the conduct of monetary policy been - effectiveness being assessed by the responsiveness of the central bank's interest rate-setting to inflation, real output, and other information variables?

The chapter answers these questions drawing on the literature on the efficient conduct of monetary policy that is concisely captured by Bernanke and Blinder (1992)[36]. It estimates Taylor-type reaction functions for Ghana, to uncover the best empirical characterisation of monetary policy formation in this country. The chapter then forms a view on monetary policy effectiveness by relating the size of interest rate responses to information variables, with the reference coefficients provided in the literature for the attainment of the price stability objective on a sustained basis. This type of research is widespread in industrialised economies but is still comparatively rare in developing economies. The analysis in this chapter thus usefully extends this body of empirical literature.

Section 5.2 revisits the theoretical model and considers necessary modifications to the Taylor rule when applied to developing countries. It then specifies the empirical model and describes the data. This is followed in sections 5.3.1 - 5.3.4 with estimates of monetary policy reaction functions. Section 5.4 ends the chapter with a summary of findings.

[36] If the policy interest rate is an indicator of the central bank's policy stance, and if the central bank is purposeful and reasonably consistent in policy making, then the policy interest rate should be related systematically to important macroeconomic target variables.

## 5.2 The Model and Data

### 5.2.1 The Theoretical Model and its Applicability to Developing Countries

The theoretical foundation for the analysis in this chapter, the Taylor rule, presented in Section 4.1.4, is reproduced as Equation (5.1a) below.

$$i_t = 0.04 + 1.5\,(\Pi_t - 0.02) + 0.5(y_t - \tilde{y}_t) \qquad (5.1a)$$

Where $i_t$ denotes the central bank's opening interest rate target (or instrument of policy); $\Pi_t$, the inflation rate; $y_t$, the log of real GDP; and $\tilde{y}_t$, the log of potential output identified empirically with a linear trend. The number 0.02 is the 2 per cent inflation target, and 0.04 the benchmark recommendation when inflation and output are on target. The latter figure is the sum of the 0.02 percent inflation target and the assumed 0.02 percent equilibrium real interest rate.

Taylor argued that this rule is as applicable to emerging market economies (EMEs) as it is to developed market economies; and it is captured in Taylor (2000) as follows: "the use of monetary policy rules in EMEs has many of the same benefits that have been found in research and in practice in developed economies." Taylor, however, adds that market conditions in EMEs may require suitable modifications to the typical rule recommended for economies with more developed financial markets. These conditions, he notes, necessitate consideration of some five issues. First, the applicability of inflation forecasting rules; second, the appropriateness of the interest rate instrument of the Taylor rule; third, the specificity of the rule; fourth, the implications of underdeveloped long-term bond markets; and lastly, the role of the exchange rate. Each of these is now considered for the case of Ghana.

*(i) Inflation Forecast Targeting*

Laxton and Pesenti (2003) develop a variant of the IMF's Global Economic Model suitable to analyse macroeconomic dynamics in open economies, and use it to assess the effectiveness of Taylor rules and inflation-forecast-based (IFB) rules in stabilising variability in output and inflation in the Czech Republic. Their findings suggest that a simple IFB rule that does not rely upon any direct estimates of the equilibrium real interest rate and places a relatively high weight on the inflation forecast may perform better in small open economies than conventional Taylor rules.

However, Taylor recommends rules with current data for EMEs rather then forecast-based rules. His arguments are threefold. First, there is little difference between an inflation-forecast-based rule and a rule with current data, as forecasts are based on current data. Second, a rule that performs well in achieving an inflation target is not necessarily an inflation forecast-targeting rule. Third, data limitation of EMEs - an observation made by others e.g. Plenderleith (2003). This research uses current data for the analysis.

*(ii) An Appropriate Instrument*

Taylor (2000) contends that for EMEs, there may be a need to consider policy rules with a monetary aggregate as an instrument, rather than the interest rate employed in the Taylor rule. His reasoning, following Poole (1970), is that even though the use of a monetary aggregate or an interest rate as a policy instrument is equivalent, the choice between the two may be dictated by the composition of shocks the economy faces.

If shocks to investment and/or exports are large relative to velocity shocks, then a monetary aggregate is considered a better instrument. On the other hand, if shocks to velocity are large relative to shocks to investment and/or exports, then the interest rate is the more appropriate instrument. Taylor contends that for EMEs, shocks to investment and/or exports relative to velocity shocks are more significant. In addition, actual and equilibrium real interest rates for EMEs are measured with greater uncertainties[37]. From this a monetary aggregate would be considered the better

[37] Two methods are commonly used to compute the equilibrium real rate. However, both are associated with uncertainties. The more common of the two methods involves estimating the equilibrium real rate as the difference between the average interest rate and average inflation rate, both averages calculated over a long sample period. The need for a long sample period is because the equilibrium real rate, a long run concept, requires that cyclical swings in the real rate are ironed out. However, the need for a long sample is associated with disadvantages, particularly for emerging economies. For this group of countries there are structural changes over time: the equilibrium real rate is likely to change over time, hence there is difficulty in arguing for a simple equilibrium rate over any reasonably long period. The second method is the model-based approach. The difficulty with this method is that models that are able to generate realistic time series for the equilibrium tend to be large and complex systems of equations, and hence difficult to design. Also, the model's estimate of the equilibrium real rate tends only to be as good as the model itself.

instrument for Ghana. In contrast, in industrialised economies where velocity shocks are relatively higher, the interest rate is the appropriate instrument. Also, money velocity has been found to be unstable following financial sector reforms, suggesting the inappropriateness of a monetary aggregate as an instrument. Despite these arguments, from an economic modelling point of view, we deem the policy interest rate the more appropriate instrument for Ghana, following the financial sector reforms and given that it is the stated main instrument of policy by the central bank.

*(iii) The Degree of Specificity of the Policy Rule*

Taylor (2000) makes three points on the specificity of the rule for EMEs. First, for the rule to be useful, discretion is needed to incorporate other relevant variables. Second, even as the rule is modified, it ought to be reasonably specific about the variables the central bank reacts to and about the sizes of reaction to them. In this regard, the more than one-for-one interest rate response to inflation and specific response to real GDP and other important variables remains true if the price stability objective is to be attained on a sustained basis. Third, the policy interest rate ought to react quicker and by a larger amount in EMEs. Taylor's reasoning is that since monetary policy has expectations effects, usually through longer-term markets, but that these markets are underdeveloped in EMEs, there is therefore a need for speedier and more sizeable response to variables in the policy reaction function, to ensure the attainment of the price stability objective. Such a larger and speedier reaction has the added advantage of helping build credibility. Taylor's call for speedier reaction is, however, contrasted with Plenderleith (2003), who argues for a cautious response with the caution applying more when the direction of adjustment is towards an easing in stance. Disyatat and Vongsinsirikul (2003) however, see no significant difference between the two approaches. On balance therefore, the sizes of interest rate response as proposed in the Taylor rule may appear just as appropriate for emerging market/developing countries as they are for developed economies.

*(iv) The Implications of an Underdeveloped Long-term Bond Market*

For EMEs Taylor recommends the use of variables with good informational content for inflationary expectations, given that the usual channel (the long-term bond market) for the transmission and reaction to incipient inflation is poorly developed in EMEs. Such variables include: the exchange rate, the price of land, wages, and commodity prices (Taylor, 2000; Amato and Gerlach, 2002). The exchange rate, in particular, is indicated to have high pass-through to domestic prices in EMEs compared with industrialised countries (Calvo and Reinhart, 2002; Devereux and Lane, 2003).

In addition to its correlation with future inflation, there are further reasons to believe that the central banks in EMEs would guard against excessive volatility in the exchange rate. These reasons include: their relatively thin foreign exchange markets, their susceptibility to pronounced shocks and large capital flows, and the need to ward off likely financial crises that could ensue from deterioration in the accounts of firms, financial institutions, and government in the event of a large depreciation in the exchange rate. This thesis includes exchange rate as one of the information variables as its dynamics is very important to the conduct of monetary policy.

*(v) A Rendition of the Taylor Rule*

Regarding the Taylor rule stated in (4.1a), this thesis proposes a rendition more suited to Ghana as a developing country. This involves amending two aspects of the rule: the inflation target and the equilibrium real interest rate.

The Taylor rule has 0.02 - the midpoint inflation rate that typifies price stability in low inflation countries - as the inflation target. For the reasons outlined in sub-Section 1.2.2, for emerging/developing economies the inflation rate that typifies price stability can be argued to be higher. In May 2007, Ghana formally adopted an explicit inflation targeting framework for its monetary policy, after five years of implicit inflation targeting[38]. The numerical target range for inflation is announced in the context of the annual budget, and the Bank of Ghana communicates on a regular basis with the public and the markets about its goals and decisions. The current medium–term target is around 5 percent inflation. South Africa, the only other sub-Saharan African country with an explicit inflation targeting framework, has a 3-6 percent target. Thus, the first modification of the Taylor rule replaces 0.02 by 0.05 as the appropriate inflation target. Regarding the relevant inflation measure, this thesis considers it to be deseasonalised inflation, as its use avoids the problem of generating

[38] When a country establishes an inflation target but does not announce this as its primary monetary policy objective.

a suitable measure of core inflation that excludes supply-induced short-term volatility in the CPI, such as that caused by the seasonal price variations in food.

The second modification involves using a more suitable equilibrium real interest rate. The difficulties in computing this by traditional methods (see footnote 37), particularly for developing/EMEs, necessitates the use of a rather simplistic measure. We approximate the equilibrium real rate by the rate of interest on index-linked bonds with long enough maturity periods, but suitably adjusted. The interest rate (June, 2006) on a ten-year bond is 4.0 percent in Chile, while a similar instrument launched by the World Bank for Columbia with a six-year maturity has a rate of 4.4 percent. Given that capital is scarcer in African economies than in these two countries, it would be expected to command a higher real rate of return. The current rate on a five-year Ghanaian bond (Golden Jubilee Saving Bonds) launched in March 2008 is 16.1 per cent. The annual inflation rate is about 11 percent (BOG, 2007). Thus, the appropriate equilibrium real rate is estimated at 5.0 percent. This level of equilibrium rate of interest coincides with the approximately 5.0 per cent average rate of growth for Sub-African countries (World Bank, 2007). Also Ghana's GDP growth rate has averaged about 5.0 percent in the last five years (BOG, 2007).

The figure 0.05, thus, replaces the 0.02 equilibrium real interest rate of the Taylor rule. With these two modifications, the amended Taylor rule that is expected to be more suitable for Ghana is shown as Equation (5.1b):

$$i_t = 0.10 + 1.5\,(\Pi_t - 0.05) + 0.5(y_t - \tilde{y}_t) \qquad (5.1b)$$

the constant term, 0.10, being the sum of the estimated equilibrium real interest rate and the inflation target. The coefficients indicating the strength of interest rate responses to deviations of inflation and output from their respective targets are, however, left unchanged[39].

[39] As a possible area for future research, the modified rule proposed in this thesis for Ghana can be applied to a broad sample of developing countries to determine its fit vis-à-vis countries' actual performance. This would enable it to serve as a bench-mark rule for this group of developing countries.

### 5.2.2 The Empirical Model Selection

#### *5.2.2.1 Background to Empirical Model Selection*

It would be fairly straightforward to estimate a Taylor rule as the empirical model. This would involve simply replacing the rule-based recommended nominal funds rate with the historical series, adding a residual error term to capture deviations from the rule and estimating the coefficients as the weights. With the observation that the central bank adjusts interest rates gradually, the rule can be extended by the lagged interest rate. Furthermore, the rule can be extended by variables such as those discussed in sub-Section 3.1.5.4. Indeed, this has been the approach adopted in a number of estimations of central bank policy reaction functions. An example is Aron and Muellbauer (2000) who specify and estimate:

$$i=\delta_0+\delta_1 i_{t-1}+ \delta_2\Delta_4 LnP^F{}_{t+k}+ \delta_3 x^F{}_{t+m}+ \delta_4 z_t+ \delta_5 i^{USA}{}_{t-1}+ \varepsilon_t \qquad (5.2)$$

where $i$ is the central bank's short term interest rate; $\Delta_4 LnP^F{}_{t+k}$ is the annual rate of change of the consumer price deflator over the horizon of $k$ quarters; $x_{t+m}$ is the output gap at $t+m$ quarters, with "$F$"signifying forecast values using information at $t-1$; $i^{USA}{}_{t-1}$ is the short-term foreign interest rate; and $\varepsilon_t$ ,the error term.

In so doing, no explicit consideration has been paid to the stationarity properties of the data. Clarida *et al*. (2000) argue that policy reaction functions of the Taylor specification assume stationarity of the data series. While this may be reasonable for industrialised countries, for developing countries, particularly those coming from economic reform, stationarity of data cannot be taken for granted, at least in the initial years following reform. Failing to consider stationarity or otherwise of data and simply estimating by OLS will lead to spurious regression problems if the data are truly non-stationary (Granger and Newbold, 1974; Phillips, 1986). Some common techniques for addressing spurious regression problems exist. Hamilton (1994 pp.557-562), for example, enumerates three ways: (i) by including lagged values of both the dependent and independent variables in the regression, (ii) by using the Cochrane-Orcutt transformation, and (iii) by estimating the variables in difference form.

Each of these methods however, has limitations. Regarding the first solution, when lagged values of both the dependent and independent variables are included in the regression, OLS estimation yields consistent estimates of all the parameters and the *t-test* on the parameters are asymptotically N(0,1). However, F-tests for the joint significance of lags on a variable have a non-standard limiting distribution. On the subject of the Cochrane-Orcutt adjustment, it only cures first-order, not higher-order serial correlation of the residuals. It also requires that the explanatory variables are strictly exogenous. The third solution, differencing of the data prior to estimation, yields regressors and error terms that are all I(0) and *t* and *F-tests* have the usual Gaussian or $\chi^2$ distribution. However, valuable information from theory concerning the long-run equilibrium properties of the data is lost as a result of the differencing. In addition, whilst it avoids spurious regression problems, if the data are not truly non-stationary differencing can result in a mis-specified regression. Also, even if the dependent and explanatory variables are truly I(1) processes, for cointegrated processes the bivariate dynamic relations between the dependent and independent variables will be mis-specified if we simply differenced both variables. Error correction methodology, which involves mixing the data in levels and in differences in the same equation, such that the combined equation captures the extent to which the system is out of equilibrium, overcomes this limitation. There are two main techniques in this line of research. The first is the two-step residual-based procedure for testing the null hypothesis of no cointegration (Engle and Granger, 1987); the second is the system-based reduced rank regression approach of Johansen (1991, 1995). However, as useful as the methods are, they require pre-testing of the data to determine if they are I(1). Importantly, their accuracy depends on the validity of the I(1) finding.

The thesis considers it undesirable to employ estimation methods that are based on the assumption that the variables have a particular order of integration in view of the acknowledged low power of stationarity tests, particularly in small samples. For this reason, we adopt the conditional equilibrium correction model (ECM) developed by Pesaran, Shin and Smith (2001) (hereafter referred to as "the PSS model", "the equilibrium correction model" or "the modified cointegration and error correction model") that is robust to the stationarity properties of the data. This model nests all three proposed solutions to the spurious regression problems (previously discussed) as special cases. Furthermore, PSS argue that their specification is more general than the cointegration analysis of partial systems carried out by Boswijk and Franses (1992), Boswijk (1995), Johansen (1991, 1995) and Urbain (1992).

#### *5.2.2.2 Assumptions Underlying the Empirical Model*

Underlying the PSS model is the assumption that the time series properties of the variables of interest, $\{z_t\}^{\infty}_{t=1}$, a $(k+1)$ vector random process, can be approximated by a VAR($p$) model augmented with the appropriate deterministic variables such as intercept and a time trend as in Equation (5.3):

$$\Phi\,(\mathrm{L})\,(z_t - \mu - \gamma t) = \varepsilon_t \qquad t = 1, 2, ..., \qquad (5.3)$$

where $L$ is the lag operator, $\mu$ and $\gamma$ are unknown ($k$+1) vectors of intercept and trend coefficients, $\Phi\,(L) = \mathbf{I}_{k+1} - \Sigma^{p}_{i-1}\,\boldsymbol{\Phi} i\,\mathrm{L}^{i}$ is a ($k$+1, $k$+1) matrix of lag polynomial; and k the number of regressors. Specific assumptions underlying (5.3) are the following:

**Assumption One**: that the elements of $\mathbf{z}_t$ are purely I(1), purely I(0), or cointegrated, and excludes the possibility of seasonal unit roots and explosive roots.

**Assumption Two**: that the ($k$+1) vector of error process $\{\varepsilon_t\}_{t=1}^{\infty}$ is $IN(\mathbf{0},\boldsymbol{\Omega})$, $\boldsymbol{\Omega}$ is a positive definite matrix.

Expressing the lag polynomial $\Phi\,(L)$ in a vector equilibrium correction form, PSS rewrite the VAR ($p$) model (5.3) as:

$$\Delta\mathbf{z}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \boldsymbol{\Pi}\mathbf{z}_{t-1} + \boldsymbol{\Sigma}^{p-1}_{i=1}\,\boldsymbol{\Gamma}_i\,\Delta\mathbf{z}_{t-i} + \boldsymbol{\varepsilon}_t \qquad t=1,2,..., \qquad (5.4)$$

where $\Delta \equiv 1\text{-L}$ is the difference operator, $\mathbf{a}_0 \equiv -\boldsymbol{\Pi\mu} + (\boldsymbol{\Gamma}+\boldsymbol{\Pi})\boldsymbol{\gamma}$, $\mathbf{a}_1 \equiv -\boldsymbol{\Pi\gamma}$, and
$\boldsymbol{\Gamma} \equiv \mathbf{I_m} - \boldsymbol{\Sigma}^{p-1}_{i=1}\,\boldsymbol{\Gamma}_i = -\boldsymbol{\Pi} + \boldsymbol{\Sigma}^{p}_{i=1}\, i\boldsymbol{\Phi}_i$ is the sum of the short-run coefficient matrices.
$\boldsymbol{\Pi} \equiv -(\mathbf{I_m} - \boldsymbol{\Sigma}^{p}_{i=1}\,\boldsymbol{\Phi}_i)$ is the long-run multiplier matrix.

Partitioning $\mathbf{z}_t$ into a scalar variable $y_t$ and a $k$-vector $\mathbf{x}_t$ and partitioning the error term $\boldsymbol{\varepsilon}_t$ conformably with $\mathbf{z}_t = (y'_t, \mathbf{x}'_t)'$ as $\boldsymbol{\varepsilon}_t = (\varepsilon_{yt}, \boldsymbol{\varepsilon}'_{xt})'$ and its variance matrix as:

$$\Omega = \begin{pmatrix} \omega_{yy} & \omega_{yx} \\ \omega_{xy} & \Omega_{xx} \end{pmatrix}$$

where $\boldsymbol{\varepsilon}_{yt}$ is expressed conditionally in terms of $\boldsymbol{\varepsilon}_{xt}$ as

$$\varepsilon_{yt} = \boldsymbol{\omega}_{yx}\, \boldsymbol{\Omega}^{-1}_{xx}\, \boldsymbol{\varepsilon}_{xt} + u_t \qquad (5.5)$$

where $u_t \sim IN(0,\omega_{uu})$, $\omega_{uu} \equiv \omega_{yy} - \boldsymbol{\omega}_{yx}\, \boldsymbol{\Omega}^{-1}_{xx}\, \boldsymbol{\omega}_{xy}$,and $u_t$ is independent of $\boldsymbol{\varepsilon}_{xt}$.

Substituting (5.5) into (5.4) and together with a similar partitioning of

$\mathbf{a}_0 = (a_{y0}, \mathbf{a}'_{x0})'$, $\mathbf{a}_1 = (a_{y1}, \mathbf{a}'_{x1})'$, $\boldsymbol{\Pi} = (\boldsymbol{\pi}'_y, \boldsymbol{\Pi}'_x)'$, $\boldsymbol{\Gamma} = (\boldsymbol{\gamma}'_y, \boldsymbol{\Gamma}'_x)'$, $\boldsymbol{\Gamma}_i = (\boldsymbol{\gamma}'_{yi}, \boldsymbol{\Gamma}'_{xi})'$, $i$=1,…, $p-1$,

PSS derive the conditional model for $\Delta y_t$ in terms of $\mathbf{z}_{t-1}$, $\Delta\mathbf{x}_t$, $\Delta\mathbf{z}_{t-1}$,…….; i.e. the *conditional* ECM of the form:

$$\Delta y_t = c_0 + c_1 t + \boldsymbol{\pi}_{y.x}\, \mathbf{z}_{t-1} + \boldsymbol{\Sigma}^{p-1}_{i=1}\, \boldsymbol{\psi}'_i\, \Delta\mathbf{z}_{t-i} + \boldsymbol{\omega}'\, \Delta\mathbf{x}_t + u_t \qquad t = 1, 2, \ldots, \qquad (5.6)$$

where $\boldsymbol{\omega} \equiv \boldsymbol{\Omega}^{-1}_{xx}\boldsymbol{\omega}_{xy}$, $c_0 \equiv a_{y0} - \boldsymbol{\omega}'\mathbf{a}_{x0}$, $c_1 \equiv a_{y1} - \boldsymbol{\omega}' a_{x1}$, $\boldsymbol{\psi}'_i \equiv \gamma_{yi} - \boldsymbol{\omega}'\, \boldsymbol{\Gamma}_{xi}$, $i$ =1,…..p-1 and $\boldsymbol{\pi}_{yx} \equiv \boldsymbol{\pi}_y - \boldsymbol{\omega}'\boldsymbol{\Pi}_x$ and the deterministic relations given by:

$c_0 = -\boldsymbol{\pi}_{y.x}\boldsymbol{\mu} + (\boldsymbol{\gamma}_{y.x} + \boldsymbol{\pi}_{y.x})\boldsymbol{\gamma}$ $\quad c_1 = -\boldsymbol{\pi}_{y.x}\, \boldsymbol{\gamma}$ where $\boldsymbol{\gamma}_{y.x} \equiv \boldsymbol{\gamma}_y - \boldsymbol{\omega}'\, \boldsymbol{\Gamma}_x$

Partitioning the long-run multiplier matrix $\boldsymbol{\Pi}$ conformably with $\mathbf{z}_t = (y_t, \mathbf{x}'_t)'$ as

$$\Pi = \begin{pmatrix} \pi_{yy} & \pi_{yx} \\ \pi_{xy} & \prod_{xx} \end{pmatrix}$$

And assuming that the k vector $\boldsymbol{\pi}_{xy} = 0$ (**assumption 3**) yields:

$$\Delta\mathbf{x}_t = \mathbf{a}_{x0} + \mathbf{a}_{x1} t + \boldsymbol{\Pi}_{xx}\mathbf{x}_{t-1} + \boldsymbol{\Sigma}^{p-1}_{i=1}\, \boldsymbol{\Gamma}_{xi}\, \Delta\mathbf{z}_{t-i} + \boldsymbol{\varepsilon}_{xt} \qquad t = 1,2,\ldots, \qquad (5.7)$$

Thus the $\{\mathbf{x}_t\}^{\infty}_{t=1}$ process is regarded as long-run forcing for $\{y_t\}^{\infty}_{t=1}$ as there is no feedback from the level of $y_t$.

Assumption 3 restricts consideration to cases in which there exists at most one conditional level relationship between $y_t$ and $x_t$, irrespective of the level integration of the process $\{\mathbf{x}\}^{\infty}_{t=1}$.

Under assumption 3, the conditional ECM (5.6) becomes:

$$\Delta y_t = c_0 + c_1 t + \boldsymbol{\pi}_{yy}\mathbf{y}_{t-1} + \boldsymbol{\pi}_{yx.x}\mathbf{x}_{t-1} + \Sigma^{p-1}_{i=1}\boldsymbol{\psi}'_i\,\Delta\mathbf{z}_{t-i} + \boldsymbol{\omega}'\Delta\mathbf{x}_t + u_t \qquad t=1,2,\ldots,\ (5.8)$$

where $c_0 = -(\boldsymbol{\pi}_{yy}, \boldsymbol{\pi}_{yx.x})\boldsymbol{\mu} + [(\boldsymbol{\gamma}_{y.x} + (\boldsymbol{\pi}_{yy}, \boldsymbol{\pi}_{yx.x})]\boldsymbol{\gamma}$, $c_1 = -(\boldsymbol{\pi}_{yy}, \boldsymbol{\pi}_{yx.x.})\boldsymbol{\gamma}$, and $\boldsymbol{\pi}_{yx.x} \equiv \boldsymbol{\pi}_{yx} - \boldsymbol{\omega}'\boldsymbol{\Pi}_{xx}$.

Provided the maximum order of integration of the variables is unity, there then exists a conditional level relationship between $y_t$ and $x_t$, defined by:

$$y_t = \theta_0 + \theta_1 t + \boldsymbol{\theta}\boldsymbol{x}_t + v_t \qquad t=1,2,\ldots$$

If $\boldsymbol{\pi}_{yy} \neq 0$ and $\boldsymbol{\pi}_{yx.x} = 0'$, then $y_t \approx I(0)$, and the differenced variable $\Delta y_t$ depends only on its own lagged-level $y_{t-1}$ in the conditional ECM shown in Equation (5.8) and not the lagged level of $x_{t-1}$. If $\boldsymbol{\pi}_{yy} = 0$ and $\boldsymbol{\pi}_{yx.x} \neq 0'$, then $y_t \approx I(1)$, and the differenced variable $\Delta y_t$ depends only on the lagged-level of $x_{t-1}$ in the conditional error conditional ECM shown in Equation (5.8). If $\boldsymbol{\pi}_{yy} = 0$ and $\boldsymbol{\pi}_{yx.x} = 0'$, then there are no level effects in the conditional level effects in the conditional ECM (5.8).

#### *5.2.2.3 The Empirical Model*

Equation (5.8) is the empirical model for estimating monetary policy reaction functions. The trend term is, however, excluded as we do not expect there to be long-run linear growth which cannot be accounted for in the model. Re-arranging the term, the conditional ECM we estimate is shown as Equation (5.9).

$$\Delta \boldsymbol{i} = \mathbf{c_0} + \mathbf{b_1}\, \boldsymbol{i}_{t\text{-}1} + \boldsymbol{\Sigma}^{k}_{j=1}\, \mathbf{d}_j\ \mathbf{X}_{j(t-1)} + \boldsymbol{\Sigma}^{k}_{j=1}\, \boldsymbol{\Sigma}^{p}_{m=0}\, \boldsymbol{\psi}_{jm}\, \Delta\mathbf{X}_{j(t\text{-m})} + \boldsymbol{\Sigma}^{p}_{m=1} \boldsymbol{\delta}_m\, \Delta \boldsymbol{i}_{t\text{-}m\text{-}1} + \boldsymbol{u}_t \qquad (5.9)$$

where $c_0 \neq 0$; $i_t$ is the policy interest rate, $X_{j(t-m)}$ the information vector, and $u_t$ serially uncorrelated errors. As previously elaborated, the model is valid whether the underlying regressors are purely I(1), I(0) or mutually cointegrated.

To ensure serially uncorrelated errors sufficiently long lags of the interest rate and information variables in differences are taken. At the same time, care is taken to balance this need with the need for a sufficiently small lag length to avoid undue over-parameterisation. In effect, the research follows Hendry's general-to-specific modelling approach and the AIC which is emphasised by PSS. The model specification allows for different lag lengths on the differenced variables without affecting the asymptotic results.

An important assumption underlying (5.9) is that there is no feedback from the level of $i_t$ to the equations explaining each of the information variables in the $X_{j(t-m)}$ vector stated in the previous section. Under the assumption that the lagged interest rate, $i_{t-1}$, does not enter the sub-VAR model for $X_{j(t-m)}$, the policy reaction function is identified and can be estimated by least squares. This assumption, however, does not rule out the inclusion of lagged changes of the interest rate in the equations for the variables in the information vector.

This empirical model enables us to work with the central bank policy instrument and its information variables in a way that allows the capturing of both short-run and long-run effects; and provides a link between the variables and the steady state equilibrium. The model says that a change in the policy interest rate depends on lagged changes of itself and in the information variables plus an error correction term, $[\mathbf{b_1}\ \boldsymbol{i_{t-1}} + \boldsymbol{\Sigma^{k}_{j=1}}\ \mathbf{d}_{\boldsymbol{j}}\ \ \mathbf{X}_{\boldsymbol{j(t-1)}}]$, reflects reversion towards the equilibrium relationship. The speed of adjustment is given by the adjustment parameter, $b_1$.

The testing procedure for finding if a relationship exists between the policy interest rate and the information variables, i.e. if the information variables are the determinants of central bank interest rate setting, is a two-stage process. The first stage involves investigating the existence of a long-run (level) relationship between the policy interest rate and the information variable(s) by computing the F-statistic associated with the null hypothesis:

$H_0^{b1} : b_1 = 0 \ \cap \ H_0^d \ d^{'} = 0^{'}$

($d^{'}$ being the vector of coefficients on the lagged-levels of the variables represented in the vector X);

against the alternative hypothesis:

$H_1^{b1} : b_1 \neq 0 \ \cup \ H_1^d \ d^{'} \neq 0^{'}$ .

The alternative hypothesis not only covers the case $b_1 \neq 0 \ \cup \ d^{'} \neq 0^{'}$, but also permits the cases of $b_1 = 0 \ \cup \ d^{'} \neq 0^{'}$ and $b_1 \neq 0 \ \cup \ d^{'} = 0^{'}$.

The asymptotic distribution of this test-statistic is non-standard, irrespective of whether the regressors are I(0) or I(1), thus PSS provide asymptotic critical values. Two polar sets of critical values are provided. One set assumes all the regressors are purely I(1) and the other that they are purely I(0). For each application the sets provide a band covering all possible classifications of the variables into I(0), I(1), or fractionally integrated.

If the computed statistic falls outside the *critical value bounds*, a conclusive inference can be drawn without needing to know the integration/cointegration status of the underlying regressors. However, if the F-statistic falls inside the bounds, inference is inconclusive and depends on whether the underlying variables are I(0) or I(1).

Comparing the *F*-statistic with the relevant critical value bounds, if the test statistic is less than the lower bounds, the null hypothesis is not rejected, signifying the absence of level relationship between the policy instrument and the information variable(s). In this case, the equation is re-estimated in pure differences. However, if the null hypothesis is rejected, we test a second null hypothesis:

$\mathrm{H}_0^{b1} : b_1 = 0$ using the bounds procedure based on t-statistic $t_{b1}$.

As with the *F*-test, asymptotic critical value bounds of this test are provided for cases in which all regressors are purely I(1), purely I(0), or mutually co integrated. Rejection of $H_0^{b1} : b_1 = 0$ confirms the existence of a level relationship. On the other hand if $H_0^{b1}$ is not rejected, it implies that though a level relationship between the policy interest rate and the regressor set exits, the speed of convergence of the variables to equilibrium is so slow as not to be significantly different from zero. The second stage of the analysis is, then, to estimate the long-run interest rate responses to the information variables and make inferences about the size of coefficients. The long-run coefficients are derived by assuming that all variables are constant in equilibrium, so that Equation (5.9) reduces to:

$$0 = \mathbf{c_0} + \mathbf{b_1}\, \boldsymbol{i} + \boldsymbol{\Sigma}^{k}_{j=1}\, \mathbf{d}_j\ \mathbf{X}_j + \boldsymbol{u} \qquad (5.10)$$

The constant and level regressors then have their long-run parameters given by:

$w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$

where $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model. Therefore equation (5.10) can be re-arranged as:

$$\boldsymbol{i} = \boldsymbol{w_0} + \boldsymbol{w_j}\, \boldsymbol{\Sigma}^{k}_{j=1}\, \mathbf{X}_j + \boldsymbol{u} \qquad (5.11)$$

The long-run inflation and output gap coefficients are respectively compared with the reference values of 1.5 and 0.5 proposed by Taylor (1993), to assess the extent to which monetary policy is effective in stabilising inflationary conditions. In addition, a view is formed on whether long-run interest rate responses to the other variables are appropriately-signed and sizeable enough to facilitate the attainment of the inflation objective.

### 5.2.3 The Data

Chapter 3 established that the instrument of monetary policy is the interest rate on the 90/91-day Treasury Bill Paper until March 2002, then after, the Prime Rate. In addition, that chapter established the adoption of price stability as the primary objective of monetary policy following financial sector reforms. Furthermore, evidence was presented that the central bank considered the pace of economic activity in policy formulation. Other variables found important for monetary policy conduct were monetary and credit aggregates, the exchange rate, foreign exchange reserves and, by implication, revenue from the main exports (gold and cocoa) and foreign monetary policy. The relevance of these variables for inflation control was established in Chapter 4.

In the empirical analysis, the pace of economic activity is measured as the deviation from linear trend of the log of real private sector credit[40]. The monetary aggregates (broad money and reserve money) and the credit aggregate (private sector credit) are used as the annualised one- and three-month growth of the variables. The exchange rate is measured as the log of the real effective exchange rate; and foreign exchange reserves are also entered in logs. Given that the quantity of production is fairly stable, revenue from primary exports were proxied by the world price of gold and cocoa. These prices measured in real US dollar terms are entered in logs. The variables used were the Prime Rate, monetary aggregates, credit aggregates, the real exchange rate, foreign exchange reserves, world prices for gold and cocoa in US dollars and the US Federal Reserve fund rate as a proxy for foreign monetary policy, from 1992M1 to 2007M1.

The data are all sourced from the IMF's International Finance Statistics (IFS) and the Bank of Ghana. The research uses the data in monthly frequency for three reasons: (i) to maximise the number of degrees of freedom, (ii) to have enough variation in the sample to enable the proper identification of the slope coefficients, (iii) to match the approximate frequency of central bank monetary policy formulation. The central bank's monetary policy committee meet every other month to decide the Prime Rate.

[40] The use of private sector credit as a measure of economic activity is because of the variable's role as a leading indicator of economic activity; an observation made by Khan (2003) for example. Additionally, Khan argues that when demand for money is unstable, as it is likely to be when a country undergoes a process of financial development, policymakers may get a clearer picture of inflation or longer term economic growth by observing credit rather than monetary aggregates.

Also given the assumption that a central bank would respond to the underlying behaviour of its information variables and not to their seasonal components, we consider it important to employ series that are devoid of seasonal variation[41]. Furthermore, even as the PSS methodology is robust to the stationarity properties of the data provided the data is I(0) or I(1), there is a need to establish that the maximum order of integration of the data is indeed one. For these reasons, we investigate the seasonality and stationarity properties of the data; and deseasonalise where seasonalities are found.

Broad money, reserve money and headline inflation are deseasonalised to measure the growth in these variables. This is also because money supply increases significantly in the last quarter of every year when government pays cocoa farmers and this results in increases in headline inflation.

### 5.2.4 Testing for Unit Roots

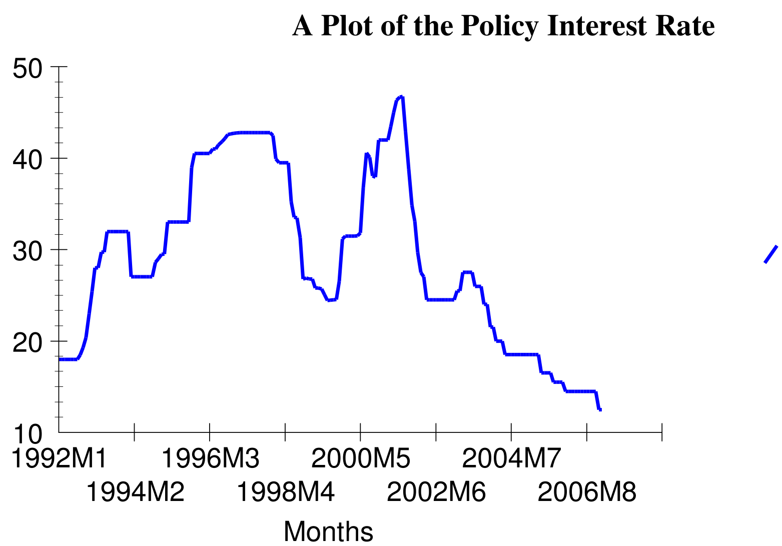
Economic time series are commonly characterised by strong trend-like behaviour. Orthodox methods of estimation and hypothesis-testing assume that all variables are stationary (trend-free). Testing for non-stationarity is now a standard pre-test that is conducted prior to all regression analysis using time series data. Although the PSS is robust regardless of variables being I(0) or I(1), we need to know if the maximum order of integration of the data is indeed one. Testing for non-stationarity may be grouped into informal and formal methods.

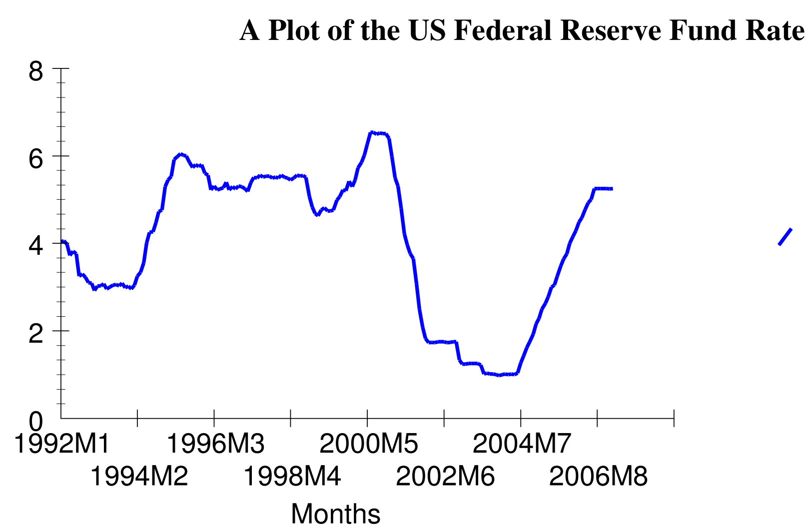
[41] Seasonal variation is defined as the systemic, though not necessarily regular, intra-year movements in economic time series that are often caused by non-economic phenomena (Thomas and Wallis, 1991).

*5.2.4.1 Informal test*

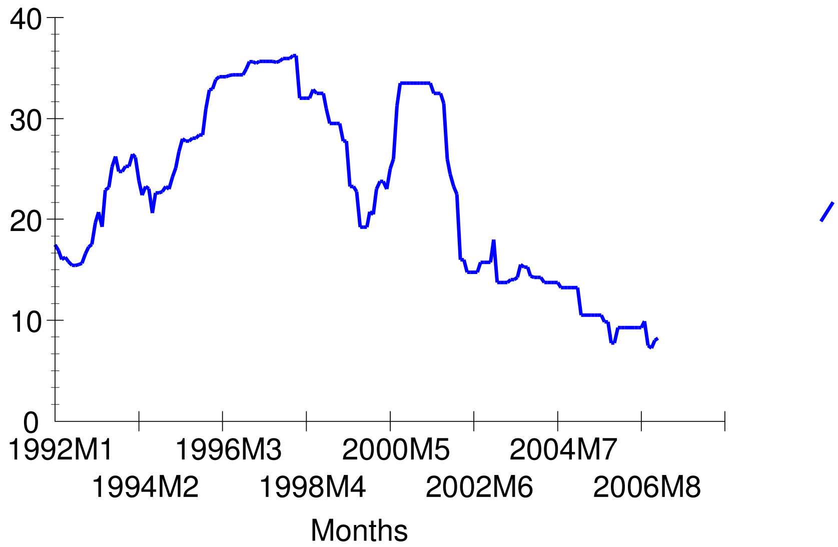
First, is a visual inspection of simple plots of the variables in levels and plots of the variables in difference.

**Figure 5.2.4.1a Plots of Variables in Levels**

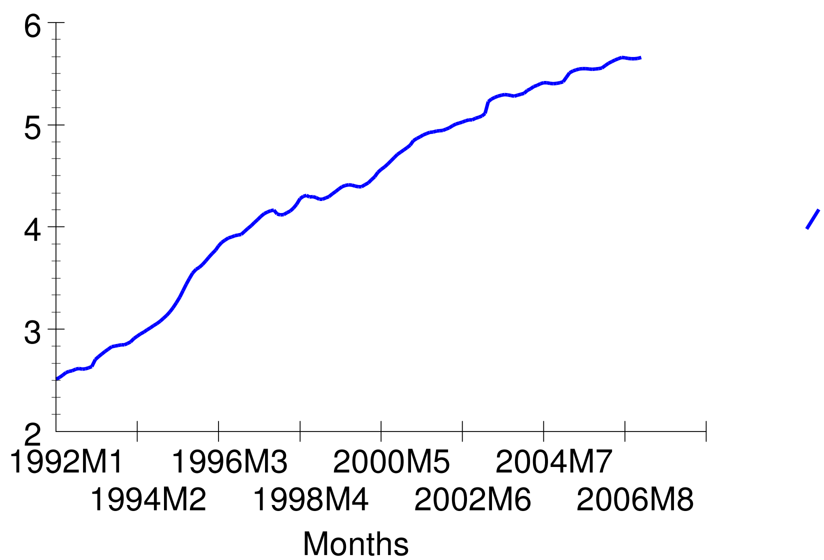


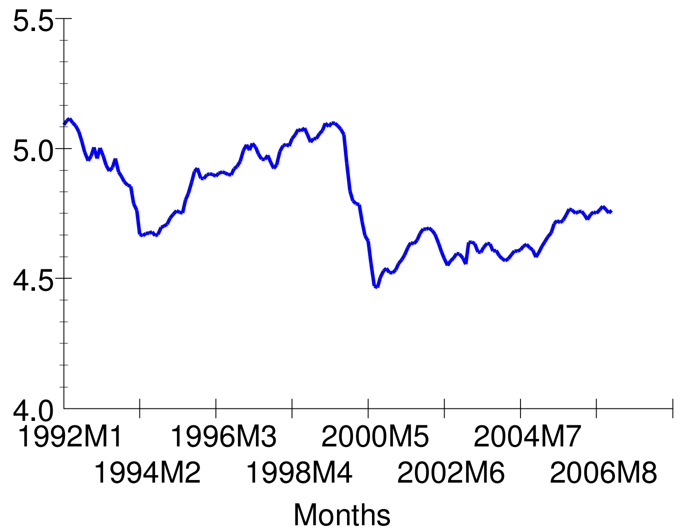
**A Plot of the Three Months Time Deposit Rate**



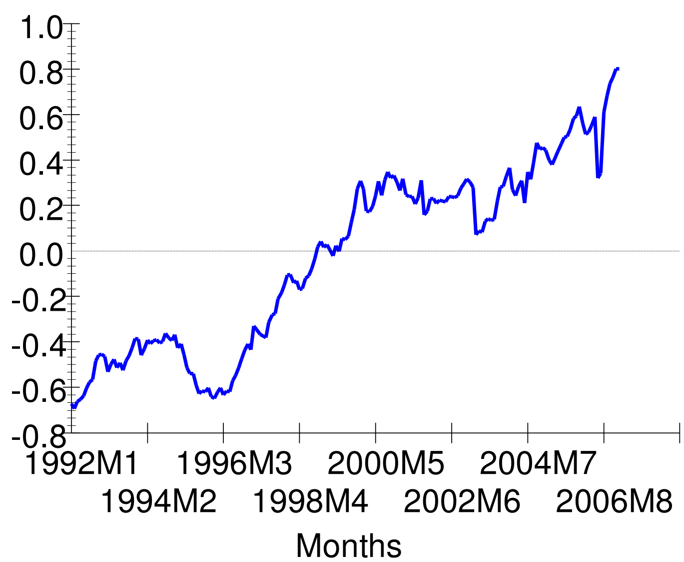

**A Plot of the Log of Headline Inflation**



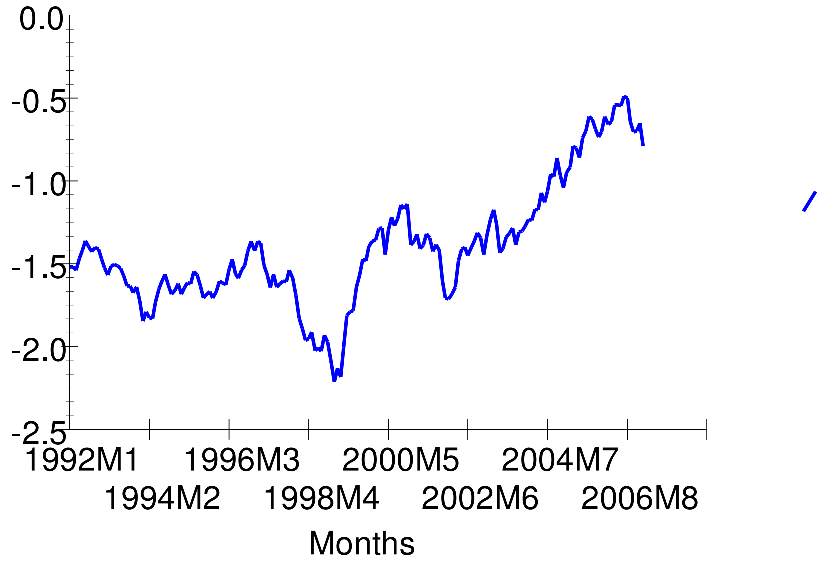
**A Plot of the Log of Real Effective Exchange Rate**



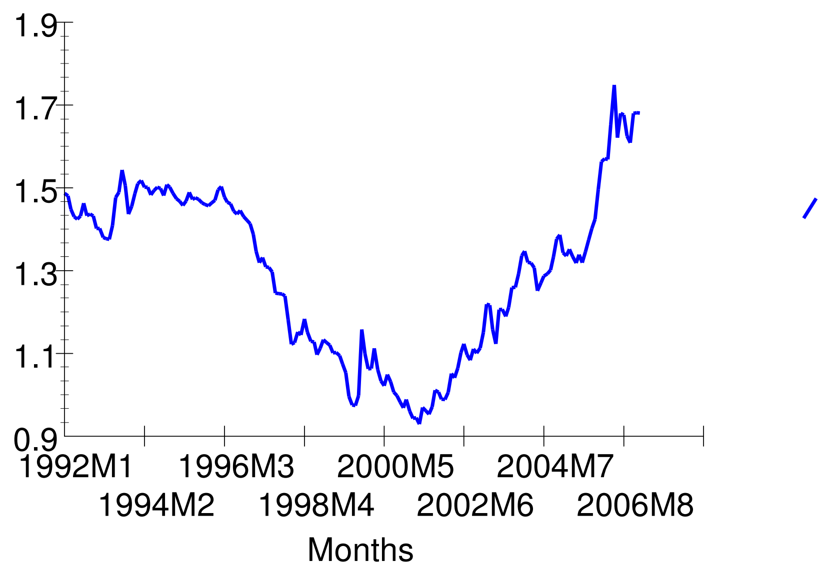

**A Plot of the Log of Real Output Gap**



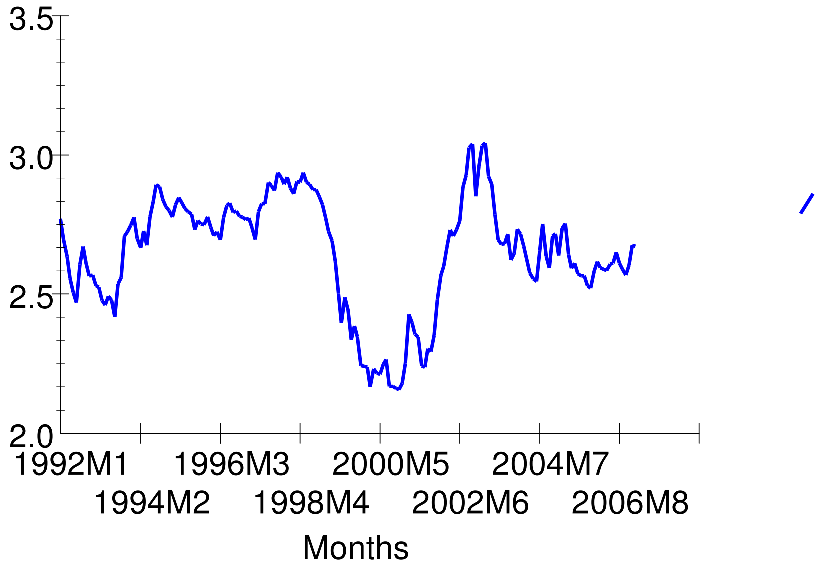
**A Plot of the Log of Real Oil Prices in US Dollars**



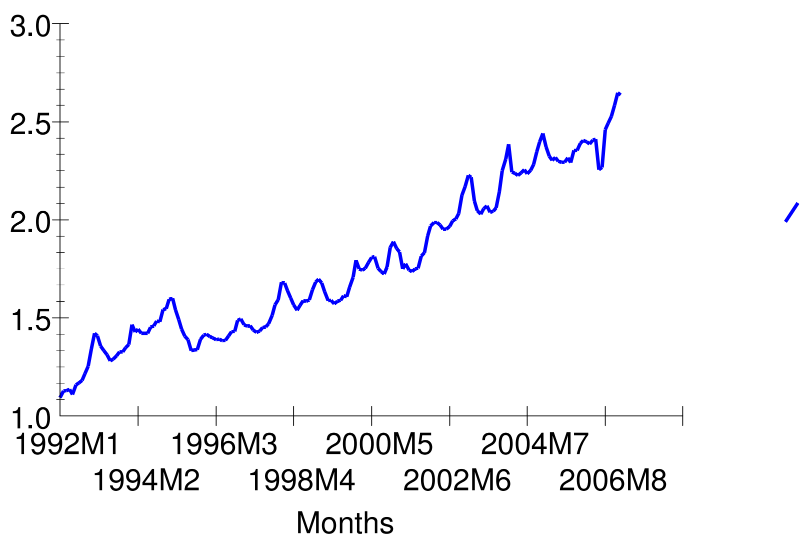

**A Plot of the Log of Real Cocoa Prices in US Dollars**



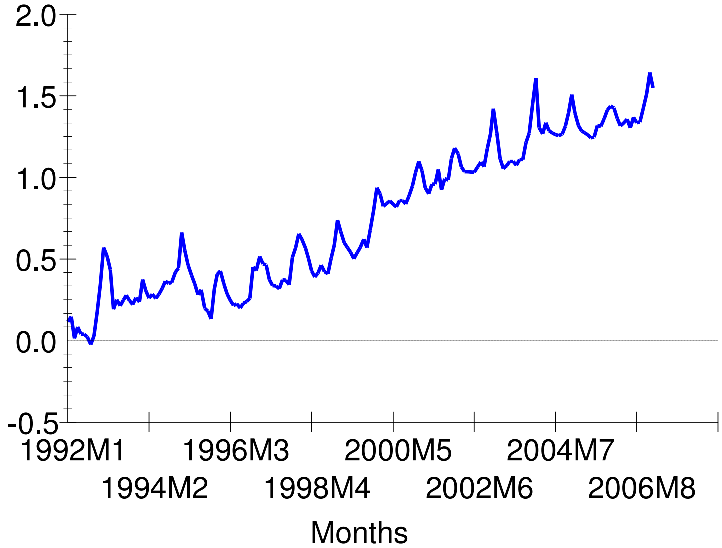
**A Plot of the Log of Real Gold Prices in US Dollars**



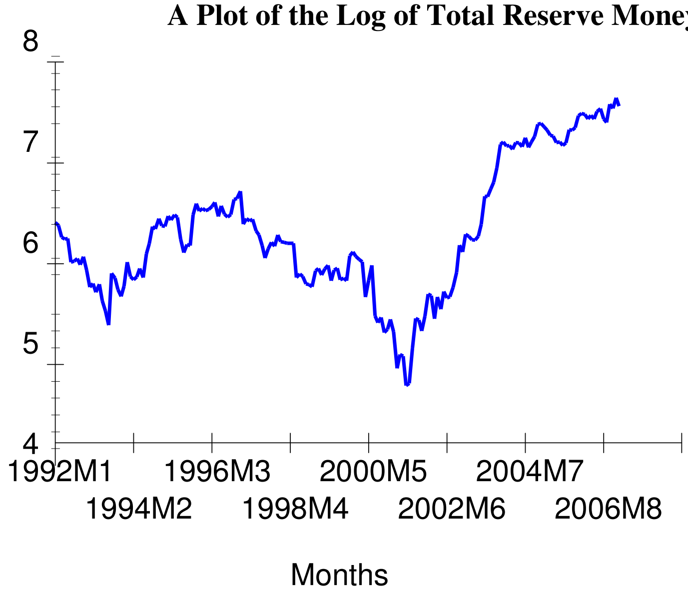

**A Plot of Real Broad Money**



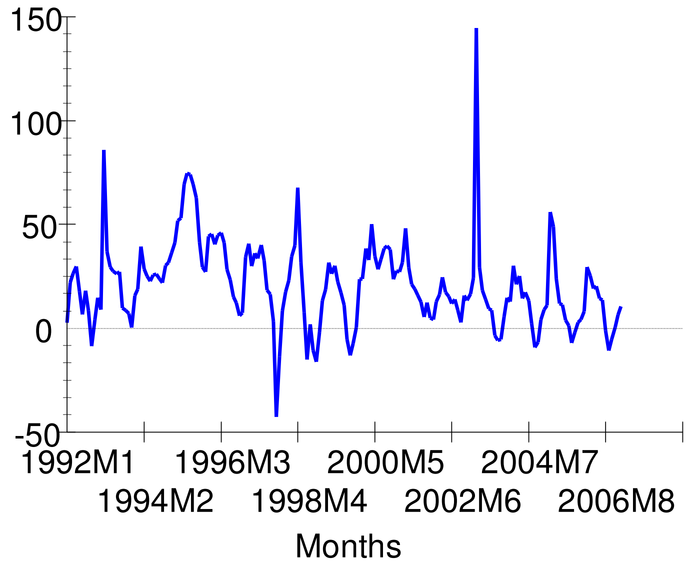
**A Plot of the Log of Real Reserve Money**



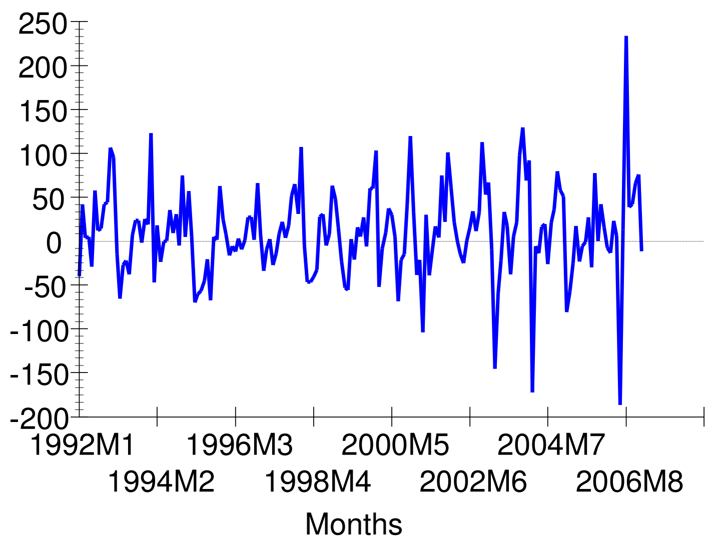

**A Plot of the Log of Total Reserve Money in US Dollars**



**A Plot of Deseasonalised Headline Inflation**




**A Plot of Deseasonalised Broad Money**



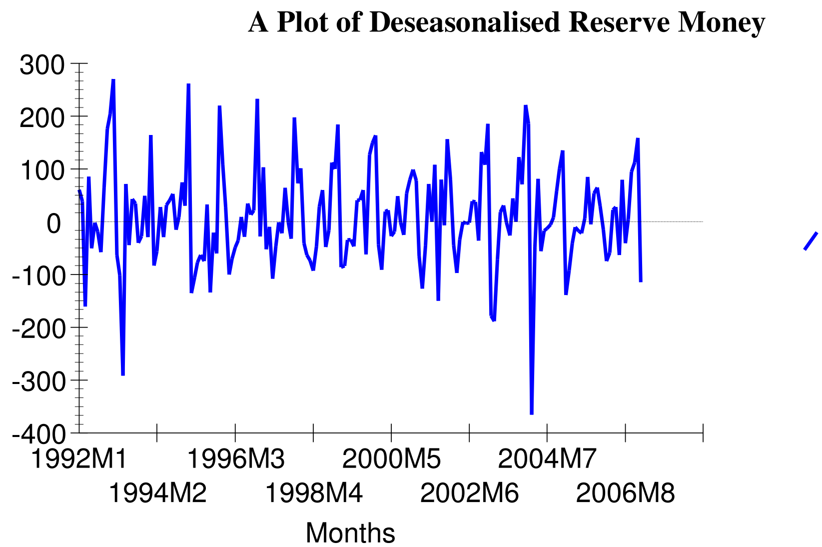
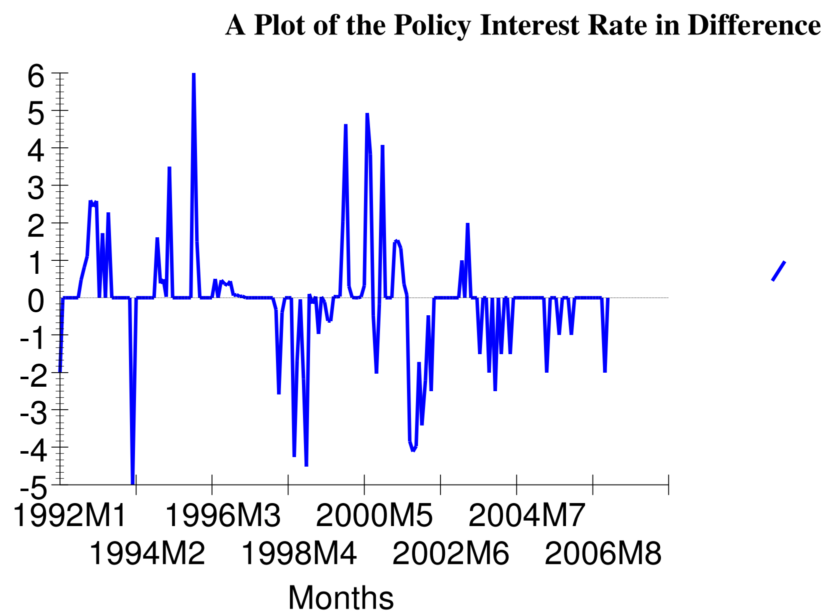
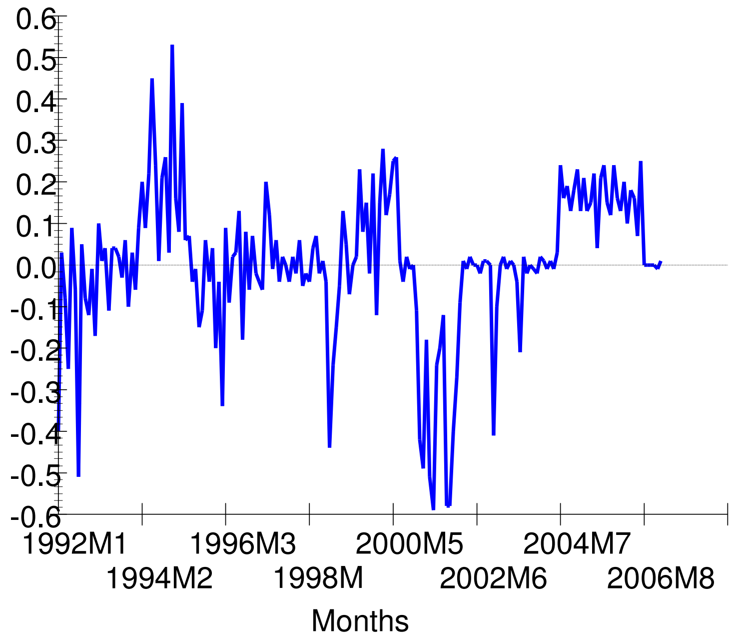


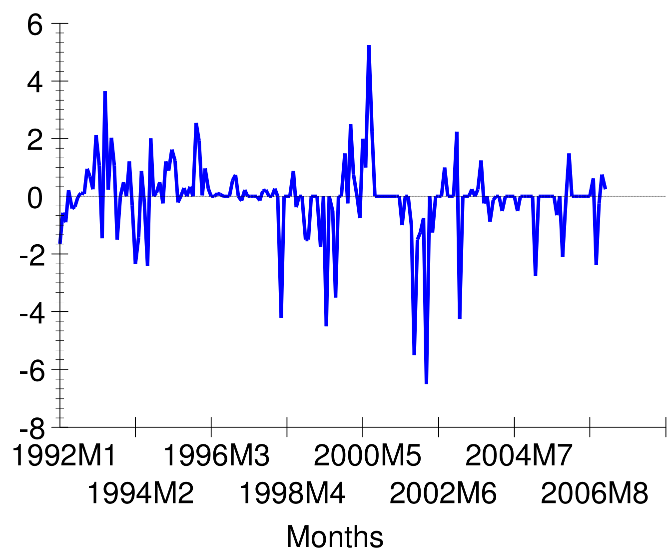

**Figure 5.2.5.1b Plots of Variables in Difference**



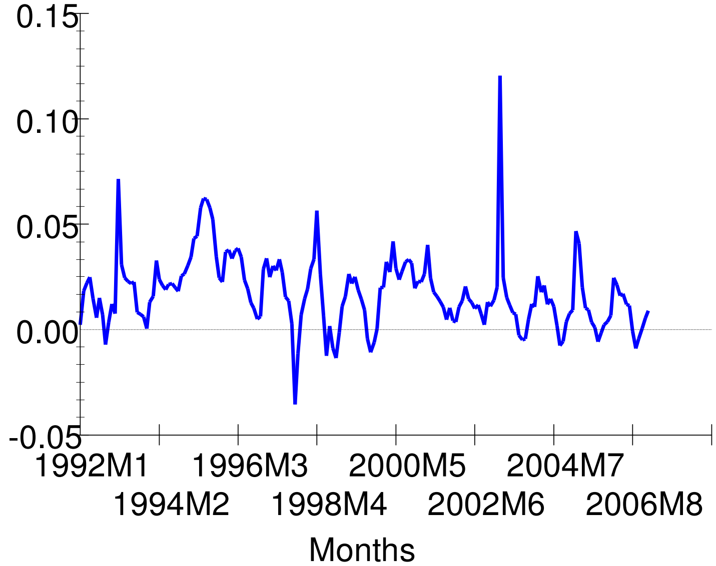
**A Plot of the US Federal Reserve Rate in Difference**



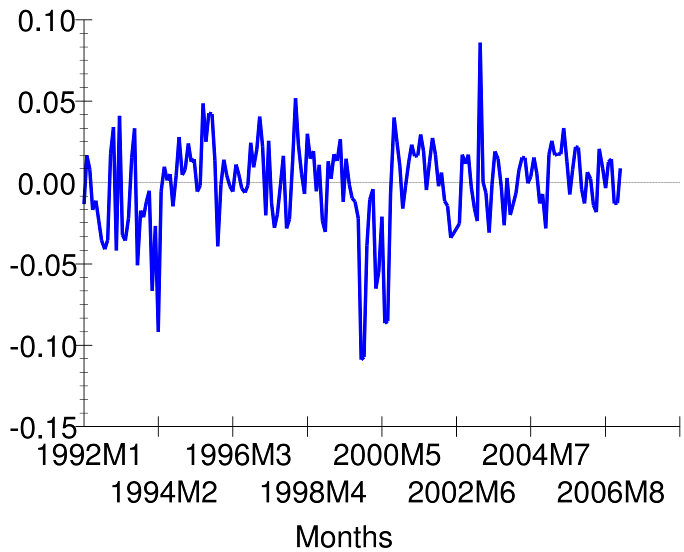

**A Plot of Three Months Time Deposit Rate in Difference**



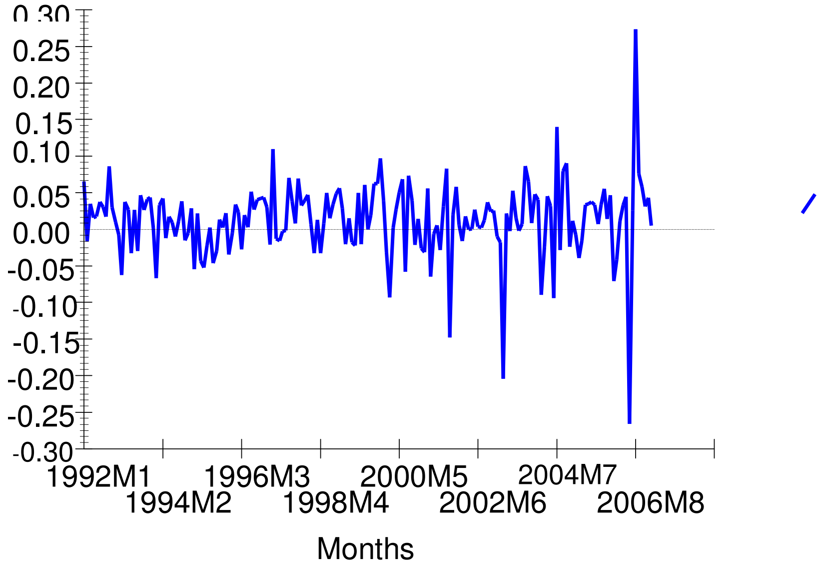
**A Plot of the Log of Headline Inflation in Difference**



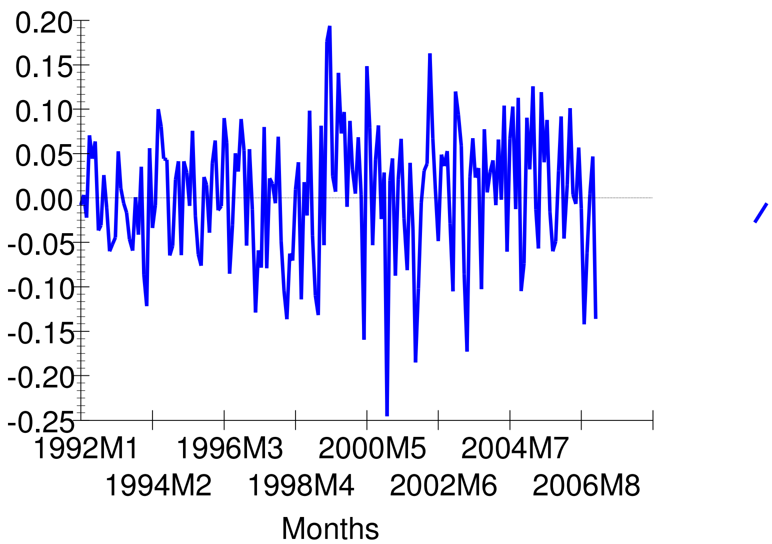

**A Plot of the Log of Real Effective Exchange Rate in Difference**



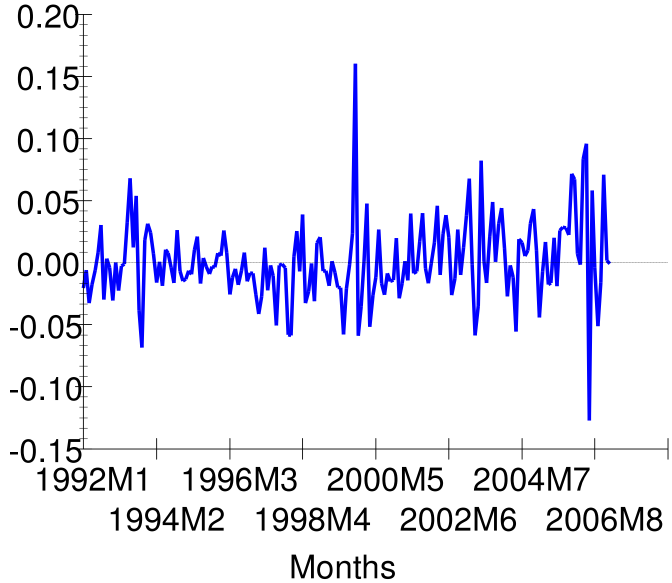
**A Plot of the Log of Real Output Gap in Difference**



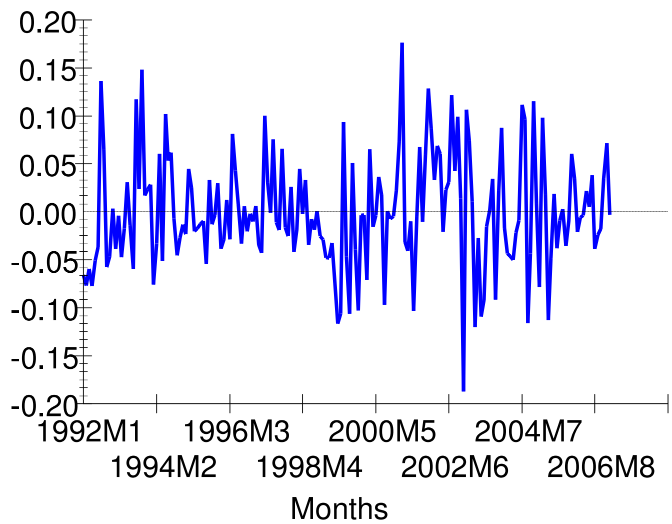

**A Plot of the Log of Real Oil Prices in Difference**



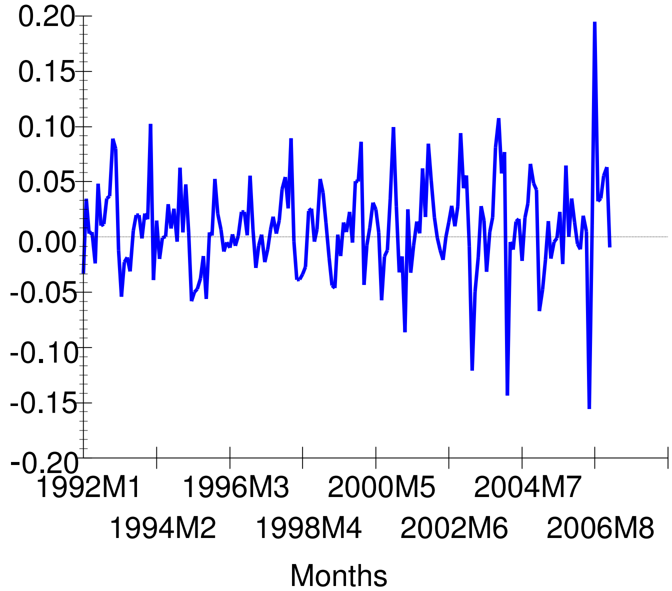
**A Plot of the Log of Real Cocoa Prices in Difference**



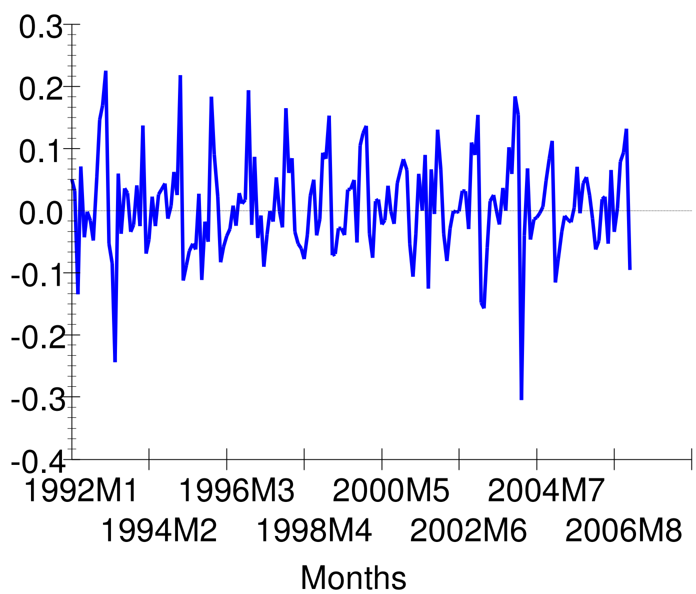

**A Plot of the Log of Real Gold Prices in Difference**



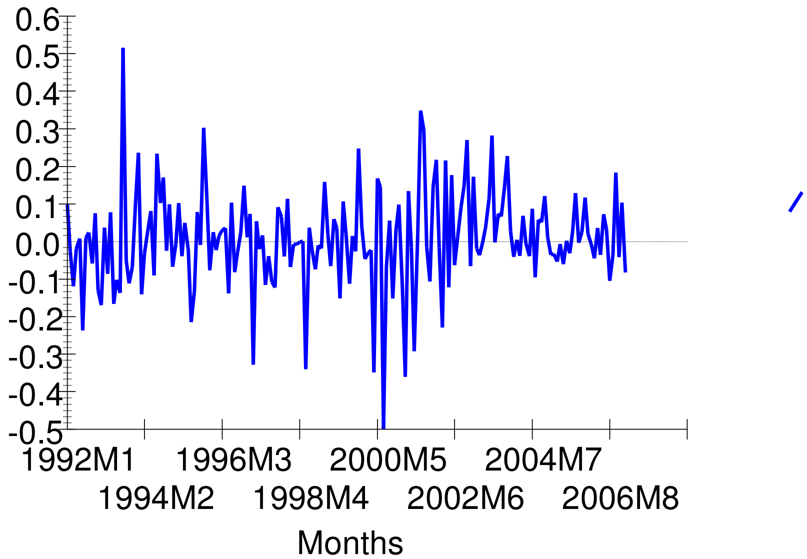
**A Plot of the Log of Real Broad Money in Difference**



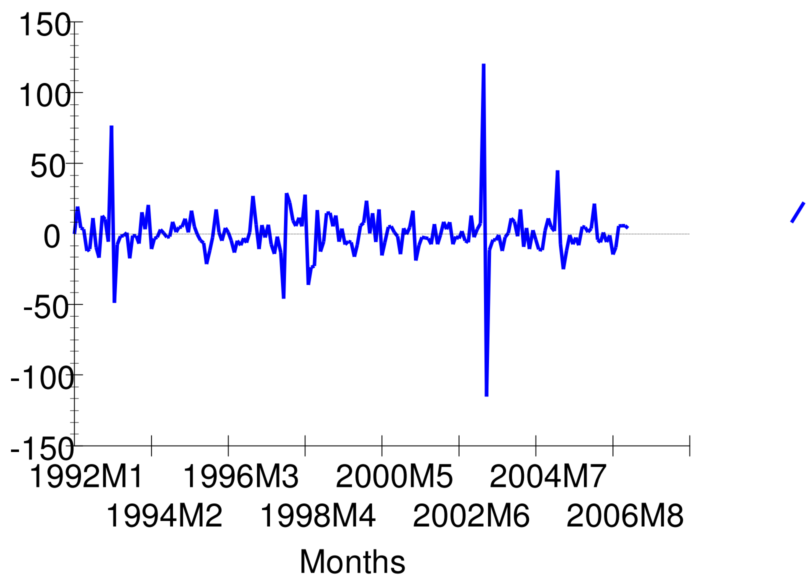

**A Plot of the Log of Real Reserve Money in Difference**



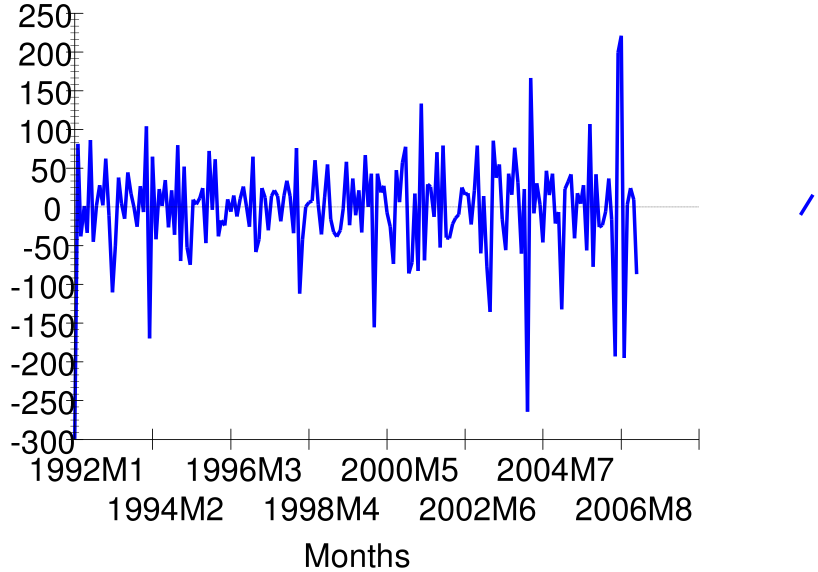
**A Plot of the Log of Total Reserve Money in Difference**



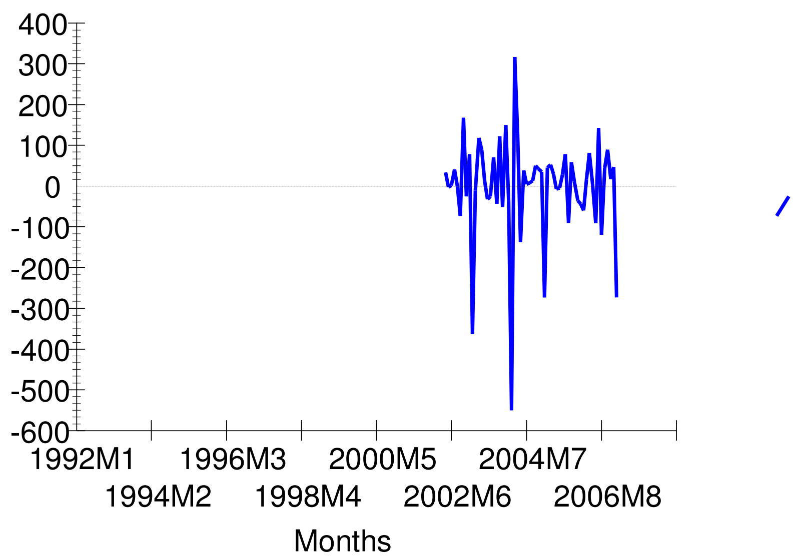

**A Plot of Deseasonalised Headline Inflation in Difference**



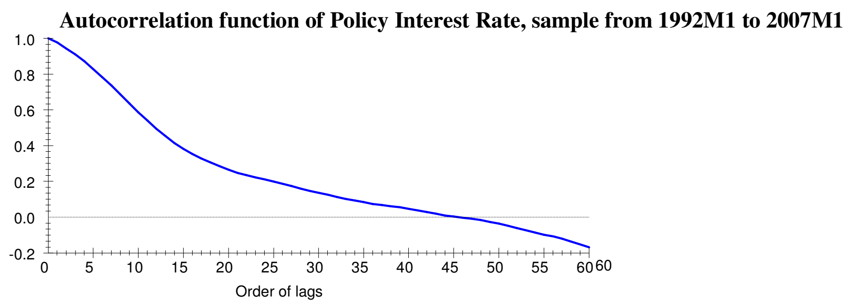
**A Plot of Deseasonalised Broad Money in Difference**

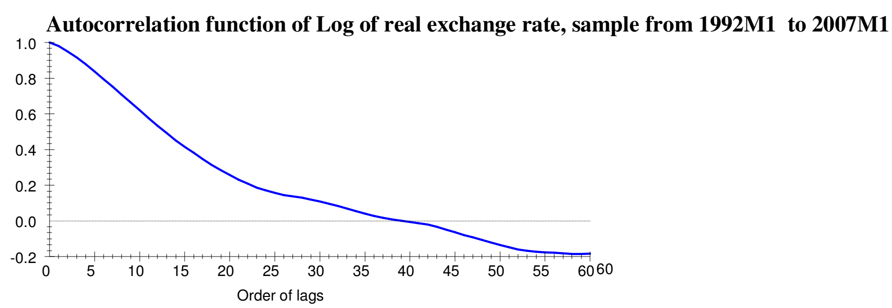


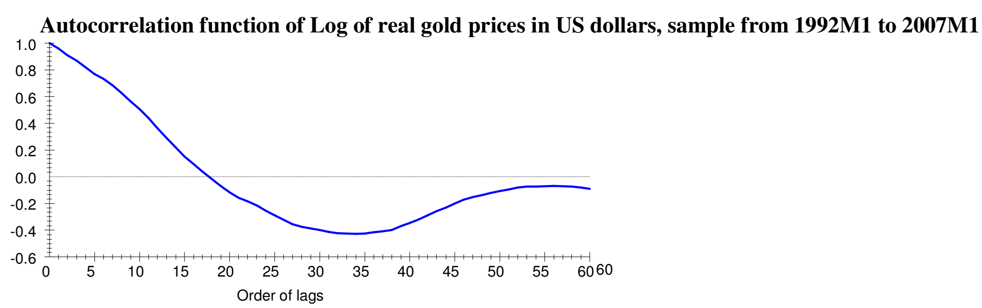

**A Plot of Deseasonalised Reserve Money in Difference**



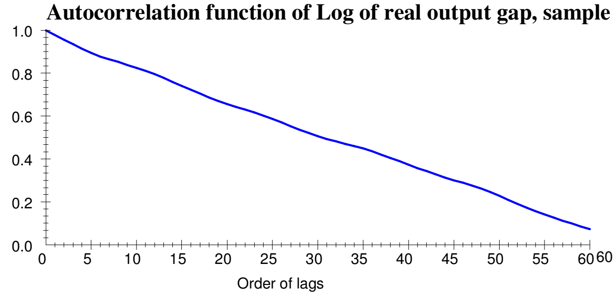
## Figure 5.2.5.1c Autocorrelation functions



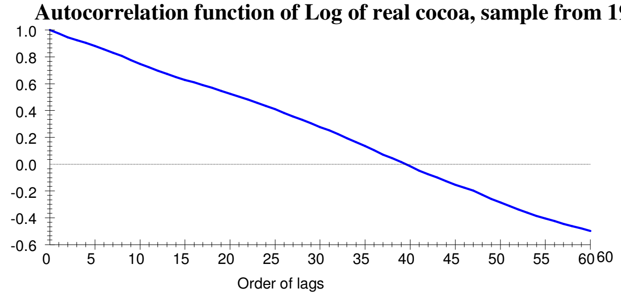



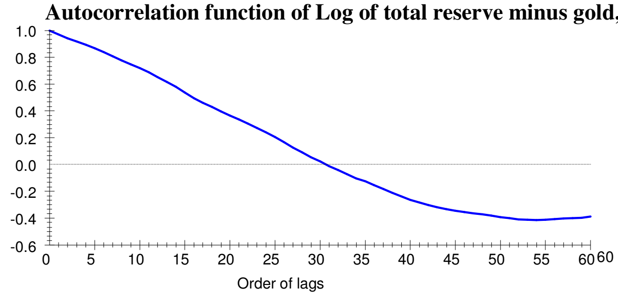
**Autocorrelation function of Log of real output gap, sample from 1992M1 to 2007M1**



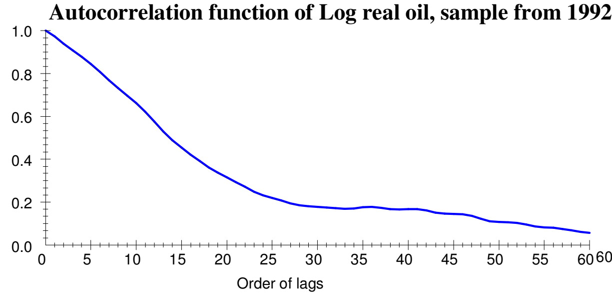

**Autocorrelation function of Log of real cocoa, sample from 1992M1 to 2007M1**



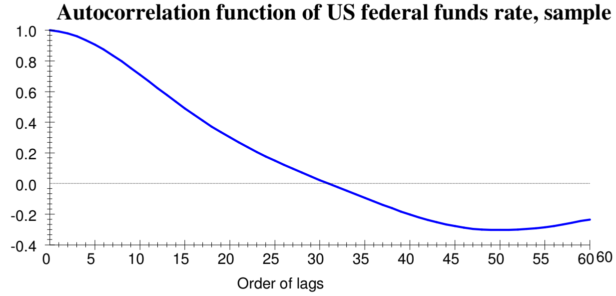

**Autocorrelation function of Log of total reserve minus gold, sample from 1992M1 to 2007M1**



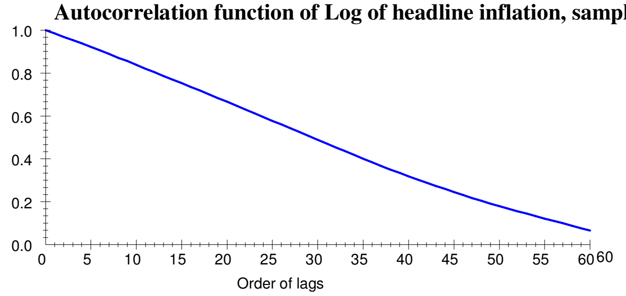
Autocorrelation function of Log real oil, sample from 1992M1 to 2007M1



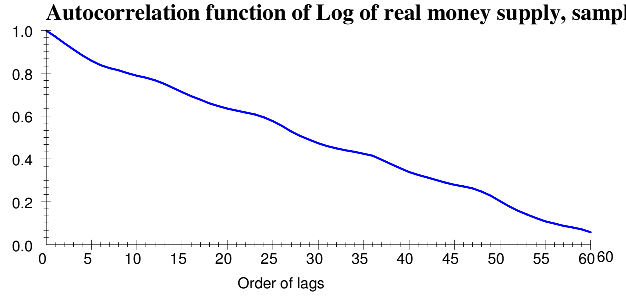

Autocorrelation function of US federal funds rate, sample from 1992M1 to 2007M1



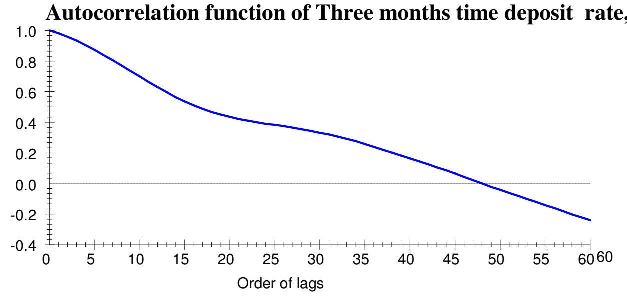

Autocorrelation function of Log of headline inflation, sample from 1992M1 to 2007M1



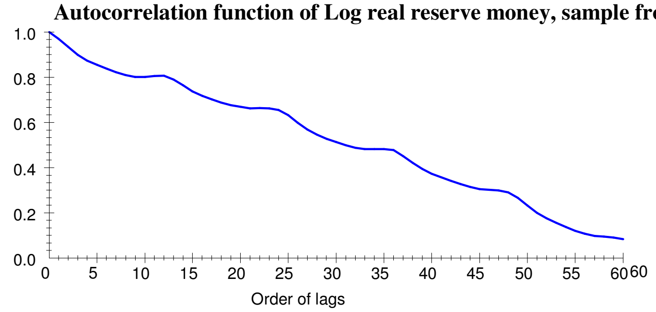
**Autocorrelation function of Log of real money supply, sample from 1992M1 to 2007M1**



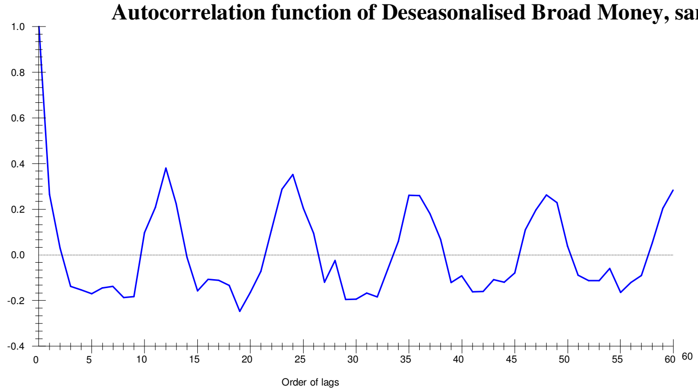

**Autocorrelation function of Three months time deposit rate, sample from 1992M1 to 2007M1**



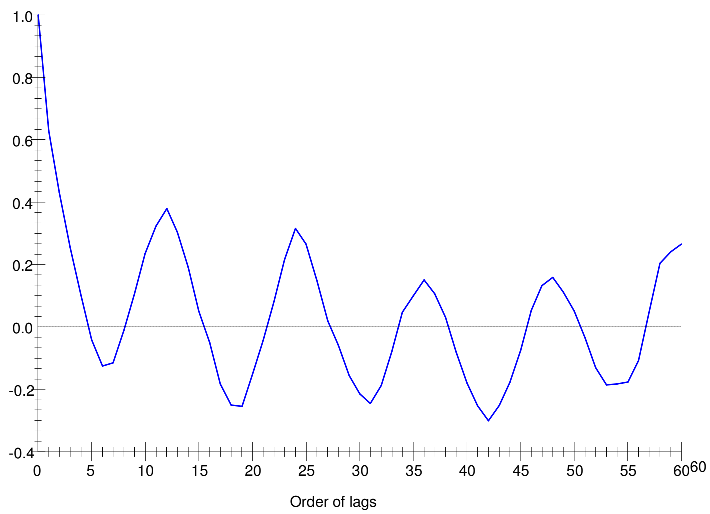

**Autocorrelation function of Log real reserve money, sample from 1992M1 to 2007M1**

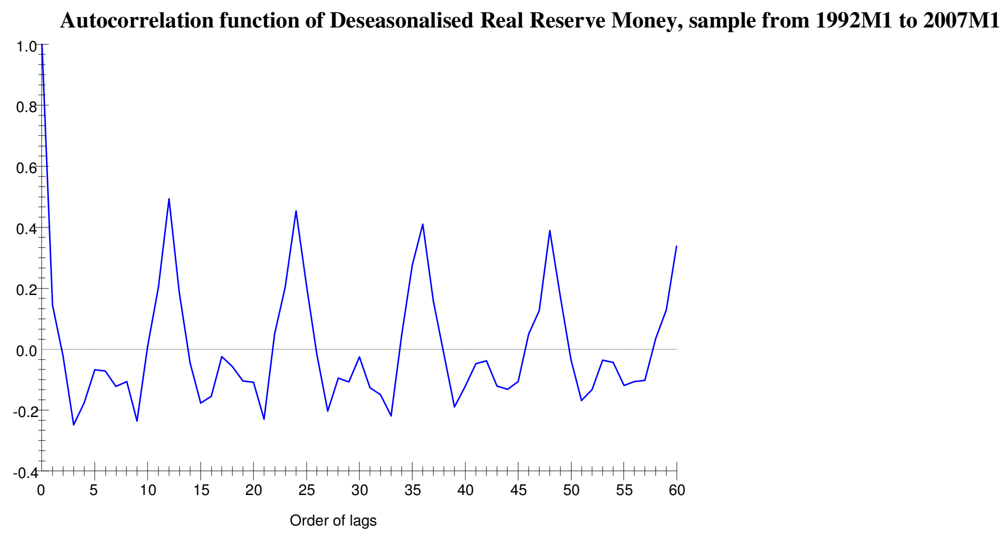


**Autocorrelation function of Deseasonalised Broad Money, sample from 1992M1 to 2007M1**




**Autocorrelation function of Deseasonalised Headline Inflation, sample from 1992 M1 to 2007M1**






The simple plots of the series over the period 1992M1 to 2007M1 in Figure 5.2.5.1a suggest that one-month annualised growth in broad money and one-month annualised growth in reserve money were the only stationary variables. The remaining variables, i.e. the Policy/Prime rate, the output gap proxy, the US federal funds rate, total foreign exchange reserves, the real US dollar price of gold, cocoa and oil, one-month annualised growth in headline inflation, the real effective exchange rate and the three months time deposit rate appeared to be non-stationary. Figure 5.2.5.1b suggests they may be I(1) variables. Figure 5.2.5.1c show that the plots start with a high autocorrelation, persists over several lags and slowly decline. Such a pattern is the autocorrelation plots signature of "strong autocorrelation" and suggests the variables are non-stationary, except one-month annualised growth in broad money, one-month annualised growth in reserve money and one-month annualised growth in headline inflation, which were found to be stationary. In fact, it is worth noting that for the stationary variables with the exception of lag 0, which is always 1 by definition, almost all of the autocorrelations fall within the 95% confidence limits. In addition, there is no apparent pattern (such as the first ten lags being positive and the next ten lags being negative). This is the pattern we expect to see if the data are in fact random.

#### *5.2.4.2 Formal test*

Testing for unit roots in autoregressive time series models continues to receive considerable attention in the econometrics literature. The formal approaches employed in this thesis for testing for stationarity are the Dickey Fuller (DF) and the augmented Dickey Fuller (ADF) tests and the Ng-Perron tests (Details of these tests are provided in the Appendix). The Dickey Fuller (DF) and the augmented Dickey Fuller (ADF) involves running the regression:

$$\Delta Y_t = \alpha_0 + \alpha_1 T + \alpha_2 Y_{t-1} + \sum_{i=1}^{m} \beta_i \Delta Y_{t-i} + \varepsilon_t \qquad (5.12)$$

Where $Y_t$ is the variable of interest and $Y_{t-1}$ is the period lag of the variable. The choice of $m$ depends largely on the number of available observations and is selected large enough to render the residual $\varepsilon_t$ white noise.

The second approach we adopted is the Ng and Perron (2001) unit root tests. Ng and Perron (2001) construct four test statistics that are modified forms of Philips and Perron (1988) $Z_\alpha$ and $Z_t$ statistics, the Bhargava (1986) $R_1$ statistic, and the Elliot et al. (1996) Point Optimal statistic. Ng and Perron (2001) argue that traditional unit root tests may suffer from two main problems. First, they may suffer from power problems when the autoregressive parameter is close to 1 and, second, when the errors of a Moving Average process are close to -1, it is necessary to have a high lag length in order to avoid size problems. However, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) tend to select a low order of the lag length. In order to overcome these issues, the authors propose a Modified Information Criterion (MIC) that controls for sample size. Additionally they propose a method utilising four tests to avoid the power problems associated to traditional unit tests:

$$\text{MZ}\alpha = (T^{-1} y_T^2 - s_{AR}^2)(2T^{-2}\sum_{t=1}^{T} y_{t-1}^2)^{-1}, \qquad (5.13)$$

$$\text{MSB} = (T^{-2}\sum_{t=1}^{T} y_{t-1}^2 / s_{AR}^2)^{1/2}, \qquad (5.14)$$

$MZ_t = MZ\alpha * MSB$ (5.15)

$$p=0:\ MP_T = [\bar{c}^{-2} T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^{2} - \bar{c} T^{-1} \tilde{y}_T^{2}] / s_{AR}^{2} \qquad (5.16)$$

$$p=1:\ MP_T = [\bar{c}^{-2} T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^{2} + (1-\bar{c}) T^{-1} \tilde{y}_T^{2}] / s_{AR}^{2} \qquad (5.17)$$

$\bar{c} = -7$ if $p=0$

$\bar{c} = -13.5$ if $p=1$

The results from the formal tests for stationarity are shown in tables 5.2.4a and 5.2.4b below.

**Table 5.2.4a** **Tests with Intercept**

| | | **Ng-Perron** | | | |
|---|---|---|---|---|---|
| **Variable** | **ADF Test** | **$MZ_a$** | **$MZ_t$** | **MSB** | **$MP_T$** |
| Policy rate | -1.217 | -2.229 | -1.016 | 0.456 | 10.693 |
| Log of Real Effective Exchange rate | -2.162 | -1.706 | -0.831 | 0.487 | 12.953 |
| Log of Real Output gap | - 0.081 | 1.809 | 2.481 | 1.371 | 146.409 |
| Log of Real Gold prices | -2.333 | -9.574* | -2.183* | 0.228* | 2.580* |

| | | | | | |
|---|---|---|---|---|---|
| Log of Real Cocoa prices | - 0.178 | -0.807 | -0.519 | 0.643 | 22.564 |
| Log of Real Oil prices | -0.819 | -1.736 | -0.666 | 0.383 | 10.611 |
| Log of Real Broad Money | 1.109 | 2.200 | 3.279 | 1.490 | 183.842 |
| Log of Headline Inflation | -1.909 | -0.023 | -0.014 | 0.612 | 25.223 |
| Log of Real Reserve Money | 0.393 | 1.740 | 2.629 | 1.510 | 173.993 |
| Log of Real Total Reserve | -0.279 | -1.959 | -0.748 | 0.382 | 10.124 |
| US Federal Funds rate | -1.719 | -6.719** | -1.799** | 0.268** | 3.766** |
| One-Month Annualised Growth in Headline Inflation | - 1.949 | -2.092 | -1.019 | 0.458 | 11.67 |
| One-Month Annualised Growth in Broad Money | -11.877* | -0.216 | -0.299 | 1.383 | 94.947 |
| Three Months Time Deposit rate | -1.185 | -3.387 | -1.213 | 0.358 | 7.198 |
| One-Month Annualised Growth in Reserve Money | -11.469* | 0.898 | 1.029 | 1.146 | 87.767 |

Note:

* Significant at 5 per cent significance level

** Significant at 10 per cent significance level

**Critical Values (Tests with Intercept)**

| | $\tau_\tau$ | $MZ_a$ | $MZ_t$ | MSB | $MP_T$ |
|---|---|---|---|---|---|
| 5% | -2.878 | -8.100 | -1.980 | 0.233 | 3.170 |
| 10% | -2.575 | -5.700 | -1.620 | 0.275 | 4.450 |

Note:The critical values for the ADF tests have been taken from Fuller (1976, p.373), and Dickey and Fuller, (1981, p.1062) and those for the Ng-Perron tests from Ng and Perron (2001).

**Table 5.2.4b**

**Tests with Intercept and Trend**

| | | Ng-Perron | | | |
|---|---|---|---|---|---|
| **Variable** | **ADF Test** | $MZ_a$ | $MZ_t$ | **MSB** | $MP_T$ |
| Policy rate | -2.185 | -2.589 | -1.003 | 0.387 | 30.554 |
| Log of Real Output gap | -2.397 | -11.698 | -2.366 | 0.202 | 8.077 |
| Log of Real Gold prices | -2.377 | -11.843 | -2.425 | 0.2048 | 7.739 |
| Log of Real Cocoa prices | 0.481 | 0.071 | 0.037 | 0.520 | 64.269 |
| Log of Real Oil prices | -2.018 | -5.134 | -1.554 | 0.303 | 17.549 |
| Log of Real Broad Money | -1.866 | -10.284 | -2.139 | 0.208 | 9.475 |
| Log of Headline Inflation | -0.969 | -2.658 | -0.905 | 0.340 | 26.652 |
| Log of Real Reserve Money | -2.291 | -4.087 | -1.399 | 0.342 | 21.971 |
| Log of Real Total Reserve | -1.152 | -3.065 | -1.110 | 0.362 | 26.739 |
| US Federal Funds rate | -1.715 | -6.929 | -1.812 | 0.261 | 13.217 |

| | | | | | |
|---|---|---|---|---|---|
| One-Month Annualised Growth in Headline Inflation | - 2.784 | -2.782 | -1.162 | 0.418 | 32.213 |
| One-Month Annualised Growth in Broad Money | -11.908* | -0.196 | -0.186 | 0.948 | 173.095 |
| Three Months Time Deposit rate | -1.699 | -4.069 | -1.347 | 0.331 | 21.529 |
| One-Month Annualised Growth in Reserve Money | -11.441* | -0.089 | -0.092 | 1.024 | 202.702 |

Note:

* Significant at 5 per cent significance level

** Significant at 10 per cent significance level

**Critical Values (Tests with Intercept and Trend)**

| | $\tau_\tau$ | $MZ_a$ | $MZ_t$ | MSB | $MP_T$ |
|---|---|---|---|---|---|
| 5% | -3.435 | -17.300 | -2.910 | 0.168 | 5.480 |
| 10% | -3.141 | -14.200 | -2.620 | 0.185 | 6.670 |

Note: The critical values for the ADF tests have been taken from Fuller (1976, p.373), and Dickey and Fuller, (1981, p.1062) and those for the Ng-Perron tests from Ng and Perron (2001).

Table 5.2.4a shows the log of real gold prices and US federal funds rate were significant under the Ng-Perron at 5 per cent and 10 per cent respectively. The one-month annualised growth in broad money and the one-month annualised growth in reserve money were significant in both tables 5.2.4a and 5.2.4b under the ADF test at 5 per cent significance level. The remaining variables were difference stationary variables i.e. they are I(1) variables. We used the PSS model that is robust to the stationarity properties of the data in our analysis.

### 5.2.5 The Estimation Strategy

The strategy for seeking the best empirical characterisation of monetary policy is to investigate the consistency of three hypotheses for the conduct of monetary policy with the data. First, that the conduct of monetary policy is one of strict inflation targeting: i.e. the central bank moves interest rates solely to inflation, even though they may observe trends in other variables. Second, that inflation and the output gap, as proposed in the Taylor rule, are the stylised variables to which the central bank responds: i.e. the central bank responds, in addition to inflation, to the pace of output either independently of its concern for inflation or as a precursor to future inflation. Third, the central bank responds to a broader information set that affects the future path of inflation or as independent objectives, e.g. the independent objective of maintenance of foreign exchange reserves.

Consistent with the three hypotheses, the research defines and employ three different information sets: $X_1$, $X_2$, and $X_3$ shown as (5.9a), (5.9b), and (5.9c) in the empirical model (5.9).

The set $X_1$ is defined to contain only inflation. The set $X_2$ comprises inflation and the output gap, while $X_3$ extends $X_2$ by the real effective exchange rate (*exrate*), foreign exchange reserve (*reserves*), the real US dollar prices of primary exports (*Ircp*) and of oil, one-month annualised broad money growth (*BMg*) and the US federal fund rate (*USFFR*). The US federal fund rate is a proxy for foreign interest rate.

$$X_1 = (Inflation) \tag{5.9a}$$

$$X_2 = (Inflation,\ Outputgap) \tag{5.9b}$$

$$X_3 = (Inflation,\ Outputgap,\ exrate,\ reserves,\ Ircp,\ BMg,\ USFFR) \tag{5.9c}$$

The procedure for assessing monetary policy effectiveness is as follows. Having ascertained the existence of a levels (long-run) relationship between the policy interest rate and the information variable(s) and computed the long-run interest rate response to inflation, output gap, and other variables where relevant, the research compares the computed inflation and output gap coefficient with the reference values of 1.5 and 0.5 proposed by Taylor (1993). With respect to the other variables, we consider if they are signed as expected and sizeable enough to facilitate the attainment of the price stability objective.

### 5.2.6 Challenges of Interpretation of Coefficient Estimates

This thesis highlights here four challenges that could impinge on the interpretation of the policy rule coefficient to be estimated. The first is the problem of identification. Identification problems can be a potential source of illegitimacy in the interpretation of the coefficients of the reaction function (Clarida *et al.*, 2000; Nelson, 2000). The identification problem could arise if the central bank controls inflation perfectly, resulting in its low variability. Such low variability, econometric theory suggests, may yield inaccurate estimates of policy response to variables, including inflation, which could invalidate the interpretation of the estimated coefficients.

Assuming that the interpretation of coefficients of the estimated policy reaction is valid, a second issue is their non-automatic link with the underlying preference parameters of policy makers (Nelson, 2000). If the aggregate demand relationship in the economy changes, so that larger interest rate changes are required to maintain the level of inflation variability at its previous level, then a welfare maximising policy-maker might increase interest rates, even though there has been no change in underlying preferences. The estimated coefficient on inflation in the policy reaction function would rise, and it would be legitimate to conclude that it indicates a stronger reaction to inflation; but it would be invalid to conclude that the weight on inflation variability in policy-makers' welfare has increased.

The third issue relates to the interpretation of the constant term in the regression. A common approach in many estimated policy reaction functions is to interpret the estimated long-run constant term as composed of the sum of the equilibrium real interest rate, $i^*$, and the inflation target, $\Pi^*$. Such analysis (e.g. Judd and Rudebusch, 1998; Clarida *et al.*, 1998, 2000) of the constant term proceeds along the lines of fixing the values of either $i^*$ or $\Pi^*$ *a priori* and then deriving the implied $i^*$ or $\Pi^*$. Unlike these studies, the research estimations do not give such a structural interpretation of the constant term. This is because of the difficulties in deriving accurate measures of $i^*$ and $\Pi^*$ from developing country data. Lastly, given that this thesis uses monthly data, the interest rate responses to be estimated are expected to be lower than would be the case if data in quarterly frequency were used.

### *5.2.7* Interest Rate Responses

Theory suggests that the long-run inflation coefficient in the policy reaction function should exceed unity for monetary policy to deliver price stability sustainably. Thus, it is expected that a rise in inflation above target would lead to a more than proportionate increase in official interest rates. Also, if output exceeds its potential i.e. if the output gap is positive, theory suggests a rise in interest rates. The size of interest rate change for a percentage point change in the output gap suggested in Taylor (1993) is 0.5. Some researchers have proposed higher weights - e. g. Ball (1999a) who proposes a weight of at least one.

There have been a number of studies on exchange rates, e.g. Gould and Kamin (2000), who argue that generally monetary authorities tighten policy during periods of strong downward pressure on the exchange rate and loosen policy as the pressure is alleviated. Similarly, Clarida (2001) argues that when a currency depreciates (relative to, say, PPP), inflationary expectations tend to rise. As such, even when the central bank is not targeting the exchange rate, the bank's desire to stabilise inflation expectations will lead it to raising nominal and real interest rates when the currency is weakening and lower the same when the currency is strengthening. This reaction, in turn, will tend to appreciate the exchange rate when it is weak and weaken the exchange rate when it is strong. Thus in practice, monetary policy aimed at achieving only domestic objectives may also serve to stabilise the exchange rate. It is, thus, expected that depreciation in the external value of the local currency would lead to an increase in interest rates, and vice versa.

It is also expected that increases in foreign exchange reserves and increases in the real US dollar price of main exports would lead to a reduction in interest rates and, under the opposite scenario, to increases in interest rates for arguments similar to those advanced for the exchange rate. It is, however, conceivable that if increases in the real dollar price of exports are expected to lead to rises in farm gate prices of these products and hence to surge in aggregate demand, interest rates may be raised.

## 5.3 Empirical Results

This section characterises Ghana's monetary policy by investigating the consistency of three hypotheses for monetary policy conduct. That is, the section investigates the representativeness of first, inflation targeting in the strictest sense; second, the baseline variable (inflation and output gap); and third, a broader information set (shown in (5.9c)) for monetary policy conduct in Ghana. The sample period is 1992M1 - 2007M1: a period when monetary policy was conducted by indirect instruments and price stability was expected to be the prominent policy objective.

Inflation is measured by headline inflation and output gap by the deviation of real private sector credit from linear trend. The policy interest rate is the interest rate on the 91-Day Treasury bill paper until March 2002, then the Prime Rate until December 2007.

**Figure 5.3: A Plot of Policy Rate and Inflation**

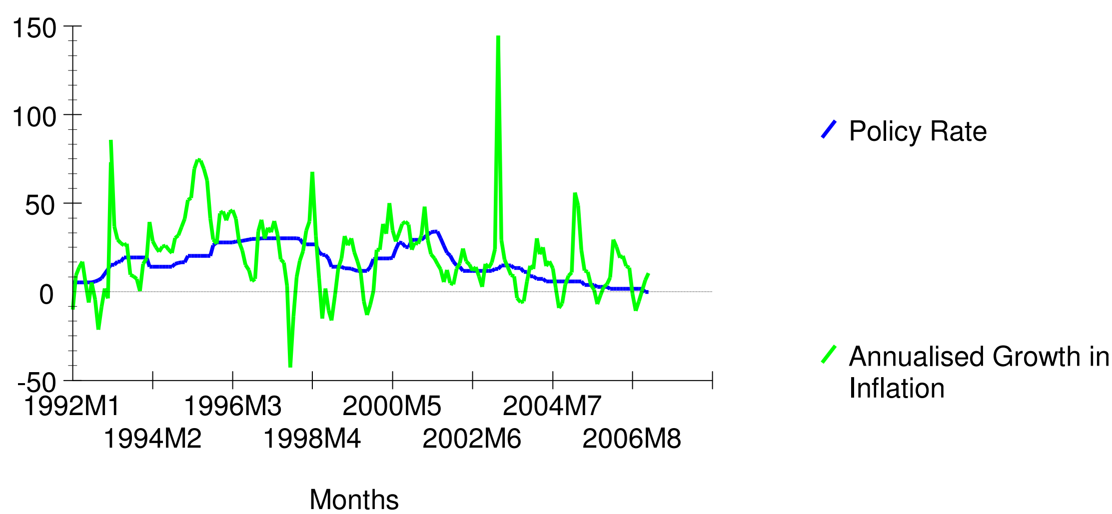



Figure 5.3 shows the policy rate below inflation over some periods in the dataset. It also shows a sharp fall in policy rate in 2002 and continuous fall thereafter, which may be a sign of a structural break in the dataset. A dummy variable (takes the value 0 from 1992M1 - 2002M3 and the value 1 from 2003M4 - 2007M1) is included to check for any structural break in the policy rate.

The estimation results are presented in Tables 5.3.1, 5.3.1a and 5.3.1b for the first hypothesis; 5.3.2 for the second. The third hypothesis is presented in Tables 5.3.3 and a summary and discussion of the results provided in Section 5.3.5.

### 5.3.1 Consistency of the Strict Inflation Targeting Assumption with the Data

Investigating the consistency of the strict inflation targeting hypothesis with the data involved the use of inflation as the sole regressor using the PSS methodology. In addition, twelve lags of monthly changes of inflation and the policy interest rate are included in the model. A binary dummy variable, which is 0 from 1992M1 -2002M3 and 1 from 2002M4-2007M1, is included to check for structural breaks.

Following the model selection, the resulting specification is reproduced in Table 5.3.1 below.

**Table 5.3.1**

The dependent variable is change in the Policy interest rate, DPR

Sample 1992 M1 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio [Prob] |
|---|---|---|---|
| C | 1.2963 | 0.48507 | 2.6724 [0.008] |
| PR(-1) | -0.043788 | 0.014146 | -3.0953 [0.002] |
| ANF1M(-1) | 0.0078840 | 0.0048059 | 1.6405 [0.103] |
| DPR(-1) | 0.34313 | 0.067228 | 5.1041 [0.000] |
| DPR(-4) | 0.16738 | 0.066544 | 2.5154 [0.013] |
| DUMM | -0.60086 | 0.27474 | -2.1870[0.030] |
| R-Squared 0.22063 | | R-Bar-Squared 0.19836 | |
| S.E. of Regression 1.2751 | | F-stat. F( 5, 175) 9.9080[.000] | |

**Diagnostic Tests**

| Test Statistics | LM Version | | F Version | |
|---|---|---|---|---|
| Serial Correlation | CHSQ(12)= | 6.6756[0.878] | F(12, 163)= | 0.52016[0.900] |
| Functional Form | CHSQ(1)= | 0.62280[0.430] | F(1, 174)= | 0.60078[0.439] |
| Normality | CHSQ(2)= | 189.6001[0.000] | Not applicable | |
| Heteroscedasticity | CHSQ(1)= | 1.1879[0.276] | F(1, 179)= | 1.1826[0.278] |

Note:

PR : Policy Interest Rate

ANF1M : The deseasonalised one-month annualised inflation

DUMM : A Dummy Variable which is 0 from 1992M1 - 2002M3 and 1 from 2002M4 - 2007M1

Variables preceded by D are the one month differences of the respective variable in levels.

Inflation in levels is insignificant but correctly-signed. The dummy variable is significant at 5 percent confirming a structural break in the data set. We therefore split the data in two to investigate the consistency of the strict inflation targeting hypothesis. Results of the dataset from 1992m1-2002m3 are shown in Table 5.3.1a and that of the dataset from 2002M4 – 2007M1 in Table 5.3.1b.

**Table 5.3.1a**

The dependent variable is change in the Policy Rate, DPR

Sample 1992M1 to 2002M3

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| C | 1.1848 | 0.58904 | 2.0113[0.047] |
| PR(-1) | -0.039941 | 0.017289 | -2.3101[0.023] |
| ANF1M(-1) | 0.0072407 | 0.0068704 | 1.0539[0.294] |
| DPR(-1) | 0.41732 | 0.081682 | 5.1091[0.000] |

| | | | |
|---|---|---|---|
| R-Squared | 0.21759 | R-Bar-Squared | 0.19787 |
| S.E. of Regression | 1.4802 | F-stat. F(3, 119) | 11.0316[0.000] |

**Diagnostic Tests**

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ(12)= 11.1813[0.513] | F(12, 107)= 0.89162[0.558] |
| Functional Form | CHSQ(1)= 1.6726[0.196] | F(1, 118)= 1.6268[0.205] |
| Normality | CHSQ(2)= 74.7208[0.000] | Not applicable |
| Heteroscedasticity | CHSQ(1)= 0.045136[0.832] | F(1, 121)= 0.044418[0.833] |

Note:

PR : Policy Rate

ANF1M : The deseasonalised one-month annualised inflation

Variables preceded by D are the one month differences of the respective variable in levels.

Inflation in levels is again insignificant but correctly-signed. Testing for the existence of a relationship in levels between the policy interest rate and inflation with a constant as the only deterministic variable in the model gives an *F*-statistic of 11.03. The high *F*-statistic implies a conclusive inference can be drawn without needing to know the integration/cointegration status of the regressors. It indicates the existence of a long-term (levels) relationship between the policy interest rate and inflation. However, the *t*-ratio of the lag of policy interest rate (2.31) being less than critical value bound of the *t*-statistic implies that although a level relationship between the policy interest rate and inflation exists, the speed of convergence of the variables to equilibrium is sufficiently slow as not to be significantly different from zero.

The long–run coefficients are derived by assuming that all variables are constant in equilibrium and given by (Pearson, Shin and Smith, 2001).

$$\boldsymbol{i = w_0 + \ w_j\, \Sigma^k_{j=1}\, \mathrm{X}_j + u} \qquad (5.11)$$

where, $w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$, $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model.

Substituting into the above equation with standard error in parentheses gives:

$$\text{PR} = 29.664 + 0.181 \text{ ANF1M}$$

$$(0.007)$$

Therefore, based on the insignificance of inflation, and its low coefficient and evidence of model misspecification, it is concluded that an assumption of inflation targeting in the strict sense may not be the most appropriate description of Ghana's monetary policy between 1992M1 and 2002M3.

**Table 5.3.1b**

The dependent variable is change in the Policy Interest Rate, DPR

Sample 2002M4 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio [Prob] |
|---|---|---|---|
| C | -0.093775 | 0.35479 | -0.26431 [0.793] |
| PR (-1) | -0.021360 | 0.017957 | -1.1895 [0.240] |
| ANF1M (-1) | 0.015847 | 0.0037474 | 4.2287 [0.000] |
| DANF1M (-9) | 0.010143 | 0.0033026 | 3.0714 [0.003] |
| DPR (-9) | -0.16313 | 0.066755 | -2.4438 [0.018] |

| | | | |
|---|---|---|---|
| R-Squared | 0.36844 | R-Bar-Squared | 0.32077 |
| S.E. of Regression | 0.59307 | F-stat. F(4, 53) | 7.7298[.000] |

**Diagnostic Tests**

| Test Statistics | LM Version | | F Version | |
|---|---|---|---|---|
| Serial Correlation | CHSQ(12)= | 15.6036[0.210] | F(12, 41)= | 1.2575[0.280] |
| Functional Form | CHSQ(1)= | 0.030742[0.861] | F(1, 52)= | 0.027577[0.869] |
| Normality | CHSQ(2)= | 19.8601[0.000] | Not applicable | |
| Heteroscedasticity | CHSQ(1)= | 1.6344[0.201] | F(1, 56)= | 1.6238[0.208] |

Note:

PR : Policy Interest Rate

ANF1M : The deseasonalised one-month annualised inflation

Variables preceded by D are the one month differences of the respective variable in levels.

Inflation in levels is now significant and correctly-signed. Testing for the existence of a relationship in levels between the policy interest rate and inflation with a constant as the only deterministic variable in the model gives an *F*-statistic of 7.73. The high *F*-statistic implies a conclusive inference can be drawn without needing to know the integration/cointegration status of the regressors. It indicates the existence of a long-term (levels) relationship between the policy interest rate and inflation. However, the *t*-ratio of the lag of policy interest rate (i.e. 1.19) being less than the critical value bound of the *t*-statistic implies that though a level relationship between the policy interest rate and inflation exists, the speed of convergence of the variables to equilibrium is slow as not to be significantly different from zero.

The long–run coefficients are derived by assuming that all variables are constant in equilibrium and given by (Pearson, Shin and Smith, 2001).

$$\boldsymbol{i = w_0 + w_j \Sigma^k_{j=1} X_j + u} \qquad (5.11)$$

where, $w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$, $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model.

Substituting into the above equation with standard error in parentheses gives:

$$PR = -4.390 + \underset{(0.004)}{0.742}\ ANF1M$$

A one per cent increase in inflation raises the policy interest rate by 0.74 percentage points, which is higher than the 0.18 percentage points witnessed between 1992 M1 and 2002 M3. The high inflation coefficient may reflect the fact that Ghana's central bank established an implicit inflation targeting framework in 2002. However, the value is still lower than the reference value of 1.5 proposed by Taylor (1993).

Therefore, based on the low inflation coefficient and evidence of model misspecification, this investigation again concludes that an assumption of inflation targeting in the strict sense may not be the most appropriate description of Ghana's monetary policy between 2002M4 - 2007M1.

### 5.3.2 Baseline Variables Specification

Extending the information set by output gap, to make the specification consistent with the Taylor rule, we began with twelve lags of monthly changes in the policy interest rate, inflation, and the output gap. The final form of the model is shown in Table 5.3.2 below.

**Table 5.3.2**

The dependent variable is Change in Policy Interest Rate, DPR

Sample 1992M1 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio [Prob] |
|---|---|---|---|
| C | 0.56078 | 0.34523 | 1.6244 [0.106] |
| PR (-1) | -0.026512 | 0.011528 | -2.2998 [0.023] |
| ANF1M (-1) | 0.0083759 | 0.0049377 | 1.6963 [0.092] |
| LLRCPS (-1) | -0.48134 | 0.27039 | -1.7801 [0.077] |
| DPR (-1) | 0.35908 | 0.067858 | 5.2916 [0.000] |

| | | | |
|---|---|---|---|
| R-Squared | 0.18985 | R-Bar-Squared | 0.17144 |
| S.E. of Regression | 1.2964 | F-stat. F(4, 176) | 10.3112[0.000] |

**Diagnostic Tests**

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ(12)= 11.3546[0.499] | F(12, 164)= 0.91473[0.534] |
| Functional Form | CHSQ(1)= 1.4587[0.227] | F(1, 175)= 1.4218[0.235] |
| Normality | CHSQ(2)= 217.5857[0.000] | Not applicable |
| Heteroscedasticity | CHSQ(1)= 0.46225[0.497] | F(1, 179)= 0.45831[0.499] |

Note:

PR : Policy Interest Rate

ANF1M : The deseasonalised one-month annualised inflation

LLRCPS: The deviation from trend of the log or real private sector credit (The measure of output gap)

Variables preceded by D are the one month differences of the respective variable in levels.

Inflation and output in levels are both significant at 10 per cent, but while inflation remains correctly-signed, output gap is incorrectly-signed. Examining the residuals (Appendix III), we find that not only are they smaller in absolute terms but also they do not exhibit the pronounced cyclical swings associated with mis-fitted models.

The computed *F*-statistic for testing the existence of a level relationship between the policy interest rate and inflation and output gap with a constant as the only deterministic variable is 10.31. At the 0.01 critical value bounds, the test statistic indicates the existence of such a relationship. The bounds *t*-test, at the 0.05 critical value bounds, confirms the existence of a relationship. However, the speed of convergence of the variables to equilibrium is sufficiently slow as not to be significantly different from zero. The long–run coefficients are derived by assuming that all variables are constant in equilibrium and it is given by equation 5.11 below:

$$\boldsymbol{i = w_0 + w_j \Sigma^k_{j=1} X_j + u} \qquad (5.11)$$

where, $w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$, $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model.

The computed long-run interest rate response to inflation and output gap is, respectively, 0.32 and -18.16.

Substituting into the above equation with standard errors in parentheses gives:

PR = 21.152 + 0.316 ANF1M – 18.156 LLRCPS

(0.005) (0.270)

The coefficients suggest that (i) holding the effect of output gap constant, a one percentage point rise in inflation leads to a 0.32 percentage point rise in the policy interest rate; and (ii) holding the effect of inflation constant, a one percent rise in output above trend leads to 0.18 percentage points reduction in the policy interest rate.

The incorrectly-signed policy interest rate response to output gap and the minute policy interest rate response to inflation suggest an absence of central bank commitment to price stability over 1992M1 - 2007M1. In particular, the incorrectly-signed interest rate response to output gap suggests that the central bank's monetary policy conduct over the period accommodated aggregate demand pressures. Possible reasons include the central bank's actual objective being one of boosting output and employment rather than maintaining price stability; and with a belief in the Phillips Curve relationship, it may deliberately have aimed to accommodate some level of inflation to achieve this objective - a typical dynamic inconsistency problem. Another plausible explanation is that, while mindful of the need to respond appropriately to aggregate demand pressures, the central bank was unable to because of the budgetary implications of rises in the Treasury bill rate, given that sizeable issues of Treasury bills are to fund the government budget. As such, large issues over and above government budgetary needs further exacerbate the fiscal burden, necessitating an accommodative monetary policy stance.

### 5.3.3 A Generalised Specification

Estimating with information set $X_3$, and with six lags of the variables in differences, the parsimonious representation has headline inflation, US Federal Reserve fund rate, and oil prices in US dollars and foreign reserve in US dollars correctly-signed and significant in levels. Output gap is significant but incorrectly-signed. In difference form, the significant variables are the policy interest rate, oil prices in US dollars, and US Federal Reserve fund rate. Broad money is found not to be significant. Table 5.3.3 shows the results.

**Table 5.3.3**

The dependent variable is Change in Policy Interest Rate, DPR

Sample from 1992M1 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| C | 6.4932 | 1.8627 | 3.4858[0.001] |
| PR (-1) | -0.32535 | 0.014705 | -2.2126[0.028] |
| FFR (-1) | 0.13466 | 0.065573 | 2.0536[0.042] |
| LLRCPS (-1) | -0.98973 | 0.32024 | -3.0906[0.002] |
| LROIL (-1) | 1.1308 | 0.44394 | 2.5472[0.012] |
| LTRMG (-1) | -0.72673 | 0.21661 | -3.3550[0.001] |
| DFFR | 1.6329 | 0.59821 | 2.7297[0.007] |
| DLROIL (-6) | 2.7744 | 1.3015 | 2.1318[0.034] |
| DPR (-1) | 0.26081 | 0.069224 | 3.7676[0.000] |

| | | | |
|---|---|---|---|
| R-Squared | 0.28266 | R-Bar-Squared | 0.24930 |
| S.E. of Regression | 1.2340 | F-stat. F(10, 172) | 8.4720[.000] |

**Diagnostic Tests**

| Test Statistics | LM Version | | F Version | |
|---|---|---|---|---|
| Serial Correlation | CHSQ(12)= | 8.8251[0.718] | F(12, 160)= | 0.68342[0.766] |
| Functional Form | CHSQ(1)= | 0.21698[0.641] | F(1, 171)= | 0.20524[0.651] |
| Normality | CHSQ(2)= | 144.6391[0.000] | Not applicable | |
| Heteroscedasticity | CHSQ(1)= | 2.5231[0.112] | F(1, 179)= | 2.5304[0.113] |

Note:

PR : Policy Interest Rate

LCPI : Log of headline inflation

FFR : US Federal Reserve fund rate

LLRCPS: The deviation from trend of the log or real private sector credit (The measure of output gap)

LROIL: Log of Oil prices in US dollars

LTRMG: Log of foreign reserves in US dollars

Variables preceded by D are the one month differences of the respective variable in levels.

Testing for the existence of a relationship in levels between the policy interest rate and inflation, output gap, US Federal Reserve fund rate, and oil prices in US dollars and foreign reserve in US dollars, the estimated *F*-statistic of 8.47 finds such a relationship at the 5 per cent level. The finding is confirmed by the bounds *t*-test, suggesting the existence of a level relationship. The long–run coefficients are derived by assuming that all variables are constant in equilibrium and it is given by equation (5.11) below:

$$\boldsymbol{i = w_0 + w_j \Sigma^k_{j=1} X_j + u} \qquad (5.11)$$

where, $w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$, $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model.

Substituting into the above equation with standard errors in parentheses gives:

$$\begin{array}{l} PR = 19.958 + 0.414FFR - 3.042\ LLRCPS + 3.476\ LROIL - 2.234\ LTRMG \\ \qquad\qquad\qquad (0.066) \qquad\quad (0.320) \qquad\quad (0.444) \qquad\qquad (0.217) \end{array}$$

The long-run policy interest rate response output gap is -0.030 suggesting that, *ceteris paribus*, a one per cent rise in output gap leads to a 0.030 percentage point fall in the policy interest rate. While the model diagnostics are good, the negative long-run response to a rise in output, together with inflation being insignificant, suggests that monetary policy was not stabilising over 1992M1 - 2007M1. The long-run response to US Federal Reserve fund rate, oil prices in US dollars and foreign reserves in US dollars are, however, significant.

## 5.4 Summary and Conclusion

This chapter has sought to find the best empirical characterisation of Ghana's monetary policy conduct over the period 1992M1 - 2007M1, by investigating the consistency of three hypotheses for monetary policy with the data. The first hypothesis was that while the central bank may observe other variables, it sets interest rates in response only to inflation. The second was that inflation and output gap are a fair representation of the central bank's information set for monetary policy conduct, as outlined by the Taylor rule. The third hypothesis was that Ghana's monetary policy conduct was better characterised by a broader information set. We then determined how stabilising Ghana's monetary policy was by comparing the long-run interest rate responses with the theoretically specified weights.

Considering the strict inflation targeting hypothesis, inflation is correctly-signed for both periods, but only significant for the period 2002M4-2007M1. There is a long-term relationship in levels between the change in policy interest rate and inflation, but the speed of convergence of the variables to equilibrium is sufficiently slow as not to be significantly different from zero. Also the residuals suggested possible omission of important variable(s).

Regarding the second hypothesis, inflation and output are both significant only at 10 per cent, but while inflation remains correctly-signed, output is negatively signed. The test statistics indicate and confirm the existence of a relationship but with this hypothesis, as in the first, the speed of convergence of the variables to equilibrium is sufficiently slow as not to be significantly different from zero. The results of a rival model test (McCallum 1995a) which uses money stock as the policy instrument are shown in Appendix XA and XB.[42]

With the broader information set, inflation is insignificant and output is significant but incorrectly-signed. Testing for the existence of a relationship in levels between the policy interest rate and inflation, output gap, US Federal Reserve fund rate, oil prices and foreign reserve both in US dollars, the estimated $F$-statistic of 8.47 finds such a relationship at the 5 per cent level. The finding is confirmed by the bounds $t$-test, suggesting the existence of a relationship in levels. However, with responses to

[42] The results appear to perform better and should be an area for future research.

inflation and broad money being insignificant, it is right to conclude that the country had no stable monetary policy in place over this period. With regards to variable significance/insignificance in levels, we find inflation correctly-signed across all specifications, and predominantly significant. Output gap is robustly negatively-signed and usually significant, strongly indicating a destabilising monetary policy. Broad money is insignificant over the period, suggesting that the central bank may have paid less attention to it than it did to inflation.

The other two variables expected to be important to the BOG are foreign exchange reserves and the exchange rate, as the central bank is charged with the management of the country's foreign exchange reserves and with the protection of the external value of the local currency. The estimations found foreign exchange reserves consistently correctly (negatively) signed and significant, however, the real effective exchange rate is insignificant, suggesting that the central bank raised the policy rate with cuts in foreign exchange reserves and vice versa, which is its foreign exchange reserves management mandate. Independently, this also suggests an absence of focus on the exchange rate, at least in real effective terms.

The significance of the US federal funds rate and US dollar price of oil suggests that the BOG conducts monetary policy taking cognisance of foreign monetary policy and international market volatility.

Inflation targeting is intended to provide benefits in terms of a credible commitment to controlling inflation along with a more consistent and predictable conduct of monetary policy. In order to preserve these benefits, some changes in the targeting procedure seem called for. In particular, it would be desirable to make the central bank response to inflation, exchange rate, output gap and money supply more transparent and allow interest rate increases to levels that are necessary to control inflation.

Chapter 6 goes beyond the monetary policy rules approach to evaluating policy effectiveness, by assessing the efficiency of policy on the basis of the strength of responsiveness of commercial bank retail rates to policy interest rate, which is the central tenet of monetary policy.

# Chapter 6

# Commercial Bank Retail Rate Response to Policy Interest Rates

## 6.1 Introduction

The monetary policy reaction functions estimated in the previous chapter evaluated monetary policy effectiveness on the basis of the size and significance of coefficients. This chapter looks beyond the monetary policy rules approach to evaluating policy effectiveness, assessing the efficiency of policy on the basis of the strength of responsiveness of commercial bank retail rates to policy interest rate. This bivariate analysis of monetary policy effectiveness serves a second purpose: to broaden the empirical literature on the responsiveness of commercial bank retail rates to changes in policy interest rates that has hardly been extended to African countries. Additionally, the investigation serves as a prelude to fuller investigation of the monetary transmission mechanism in the next chapter where the effectiveness with which monetary policy achieves some desired combination of goals is evaluated.

According to economic theory a prominent channel of monetary policy transmission is the interest rate channel. The mechanics of this channel are that a contraction of monetary policy raises the short-term nominal interest rate. Then, through a combination of sticky prices and rational expectations, the long-term real interest rate rises, at least for a period. The higher real interest rate is argued to reduce business investments and consumer durable expenditures, which cause aggregate output and employment to shrink. The important underpinning of the interest rate channel is the presumption that monetary policy has its strongest influence on short-term interest rates (Bernanke and Gertler, 1995). Notwithstanding this view, a growing body of literature (see Section 3.2) has shown that retail bank interest rates respond sluggishly to changes in the policy interest rate. The complete pass-through from changes in the policy interest rates to retail bank rates, if found, takes several months[43]. Against this background and the objectives of the chapter, this chapter explores five fundamental questions/issues. First is whether there is co-movement between commercial bank retail rates and the policy interest rate. Second is the strength of short-run response of the commercial banks retail rates to changes in the policy interest rate. Third is the extent of long-run response of commercial bank retail rates to changes in the policy interest rate and, in particular, whether this is unity. Fourth is whether the response of the commercial bank retail rates is asymmetric with respect to increases and decreases in the policy rate. Fifth is the time profile of the response of retail rates to shocks to the policy interest rate.

The chapter proceeds as follows. This introduction is followed by an outline of the analytical techniques employed for evaluating the five questions enumerated. Results from the empirical investigations then follow in Section 6.3. The chapter concludes in Section 6.4.

## 6.2 Empirical Techniques and Data

In addition to simple plots of the two interest rate series, this thesis employs two empirical techniques to investigate the responsiveness of commercial bank retail rates to policy interest rates: (i) the PSS *modified* single equation cointegration and error correction estimation method, and (ii) impulse response functions from a bivariate vector autoregression model.

### 6.2.1 Informal Graphical Analysis

Simple plots of the policy interest rate and commercial bank retail rates enable informal inferences on co-movement between the two interest rates and the likely speed of adjustment of commercial bank retail rates to the policy interest rate to be made. If the speed of adjustment is low, for extended periods of time, the spread between the two rates would tend to persist or the variability in the spread would be high. In contrast, if the response of the retail rate is rapid, the spread will be eliminated quickly, its variability would be low, and its plot would appear stationary.

[43] If lags between changes in base rate and changes in bank product interest rates do exist, the use of interest rates as the key instrument of monetary policy may not be as effective as policy-makers think. (Heffernan, 1996).

### 6.2.2 The Single Equation Cointegration and Error Correction Method

The research uses the *modified* single equation cointegration and error correction estimation method developed by Pesaran *et al.* (2001), a summary of which is provided in sub-Section 5.2.1 of Chapter 5 to quantify the short-run and long-run responses of commercial bank retail rates to the policy interest rate, and investigate asymmetries in pass-through when the policy rate increases compared to when it decreases, Specifically, we estimate equation (6.1) below:

$$\Delta TMTDR_t = c_0 + c_1 TMTDR_{t-1} + c_2 PR_{t-1} + \sum_{m=1}^{p} c_{3m} \Delta TMTDR_{t-m} + \sum_{m=0}^{p} c_4 \Delta PR_{t-m} + u_t \quad \ldots \quad (6.1)$$

The dependent variable is the change in commercial bank retail rate, $\Delta TMTDR$; and $PR_t$ is the central bank policy interest rate. As discussed in Section 5.2.1, this representation of the error correction model is superior to the traditional models of its kind as it is robust to the stationarity conditions of the data: it is valid whether the data are I(1) or I(0).

The statistic underlying the Pesaran *et al*. (2001) procedure is the *F*-statistic in a generalised Dickey-Fuller type regression. Pesaran *et al*. (2001) provide two sets of asymptotic critical values for the two polar cases - one, that all regressors are purely I(1); and two, that they are purely I(0). The two sets of asymptotic critical values provide a band covering all possible classifications of the regressors. If the *F*-statistic falls inside these bounds, inference is inconclusive and knowledge of the order of integration of the underlying variables is required before conclusive inference is made. However, if the computed *F*-statistic falls outside the *critical value bounds*, a conclusive inference can be drawn without needing to know the integration status of the underlying regressors. Where a relationship in levels is found, a related bounds test based on the *t*-statistic associated with the coefficient on the lagged-level dependent variable is conducted, to confirm the existence of the levels relationship.

Serially uncorrelated errors ($u_t$) are ensured by including sufficiently long lags of changes in the interest rates. The problem of over-parameterising is avoided by following the general-to-specific modelling strategy, and in particular the AIC that is emphasised by PSS. Having estimated equation (6.1), the test for a relationship in levels between $TMTDR_t$ and $PR_t$ is by the $F$-test for the joint significance of the lagged-level variables, where the null hypothesis is $H_0^{c1} : c_1 = 0 \cap H_0^{c2}\ c_2 = 0$;

and the alternative hypothesis is $H_1^{c1} : c_1 \neq 0 \cup H_1^{c2}\ c_2 \neq 0$.

If the null hypothesis is not rejected, it implies an absence of levels or long-run relationship between the lending rate and the policy interest rate, and a specification in first differences is estimated to prevent the risk of spurious regression. If the null hypothesis is rejected, we test the null hypothesis $H_0^{c1} : c_1 = 0$ using the bounds procedure based on the $t$-statistic $t_{c1}$. If $H_0^{c1} : c_1 = 0$ is rejected, a large value of the statistic testing the null will result, confirming the existence of a levels relationship. On the other-hand if the null is not rejected, it implies that although a levels relationship between the lending rate and the policy interest rate exists, the speed of convergence of the variables to equilibrium is so slow as not to be significantly different from zero. We derive the long–run coefficients by assuming that all variables are constant in equilibrium, so that Equation (6.1) reduces to:

$$0 = c_0 + c_1\, TMTDR + c_1\, PR \qquad (6.2)$$

which can be re-arranged as:

$$TMTDR = w_0 + w_2 PR \qquad (6.3)$$

The long-run constant, $w_0$, and the long-run coefficient on the policy interest rate, $w_2$, are given by:

$$w_0 = -\ c_0/c_1 \qquad \text{and} \qquad w_2 = -\ c_2/c_1$$

where, $c_0$ is the constant term, $c_1$ is the coefficient on the lagged-level retail rates, and $c_2$ the coefficient associated with the policy interest rate in levels in the short-run model. The long-run constant, $w_0$, reflects the mark-up on the policy interest rate, and $w_2$ reflects the long-run pass through of the policy interest rate. Under competitive market conditions and assuming a credit risk premium, the commercial bank retail rate is expected to move one-for-one with the policy interest rate (Borio and Fritz, 1995). That is, $w_2$ is expected to equal one.

Inferences on short-run behaviour are made from coefficients on the terms in differences. The coefficient $c_{40}$ reflects the immediate pass-through of changes in the policy rate; $c_{41}$, the pass-through after one month, etc. Short-run behaviour is also inferred from the coefficient on the lagged-level lending rate. This statistic gives the extent of error correction in one month.

To answer the question of whether transmission is faster if the policy rate increases than if it decreases, we include interactions of a dummy that takes a value of one if the policy rate has risen compared to the month before and zero otherwise with changes in the policy interest rate. Where relevant, lags of the interacted dummy are included.

### 6.2.3 Vector Error Correction Analysis

Although the cointegration and error correction framework would provide information on the short and long–run relationships between the policy interest rate and commercial bank savings rate, it is important to combine this with additional information on the dynamics of this relationship. In particular, we are interested in knowing how long, on average, it takes for the retail rate to settle to its long-run steady state after being shocked. To shed light on this, this thesis uses impulse response functions from a vector error correction (VECM) model. The specification of the VECM used is outlined in Section 6.3.3.

### 6.2.4 The Data

The estimation uses monthly series of the policy interest rate and commercial bank savings interest rate, given the emphasis on adjustment path. This is also in line with the empirical literature. The research uses savings interest rates as there are no reliable data on lending rates over the period. The policy interest rate is the 90 day Treasury bill instrument up to March 2002, then the Prime rate afterwards. The policy rate is from the IFS but the retail rate is from BOG database, and is the simple average of commercial bank sector savings rates.

The sample period remains as in Chapter 5 i.e. 1992M1-2007M12. During this period, as argued in Chapter 3, commercial bank interest rates and credits were not administratively controlled and in March 2002, BOG became administratively independent.

## 6.3 Empirical Results

This section analyses monetary policy effectiveness, measured by the responsiveness of the commercial bank savings rate to changes in the policy interest rate. This investigation employs three techniques - graphical analysis, the PSS *modified* single equation cointegration and error correction method, and bivariate VAR/VCEM model. The results are presented in this order.

### 6.3.1 Graphical Analysis

Figure 6.3.1a plots the levels of the prime rate (PR) and the commercial bank savings rate (TMTDR) while Figure 6.3.1b plots the spread between the two rates. Figure 6.3.1a shows the TMTDR and PR generally moving together, but at varied rates of change. Figure 6.3.1b, which shows the spread as trended, reinforces the observed varied rates of change of the two interest rates. However, a DF *t*-statistic ($\tau_{\mu}$) of -3.5744 (see Appendix Table I) indicates stationarity of the spread at the 5 per cent significance level and suggests a presence of a levels relationship between the two interest rates over the period 1992M1-2007M1.

**Figure 6.3.1a**

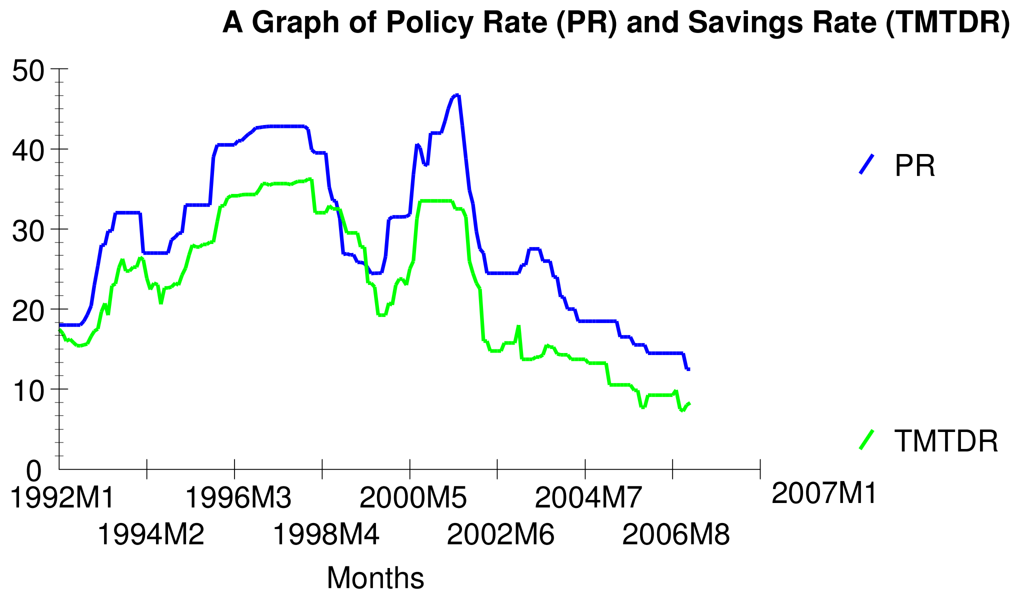
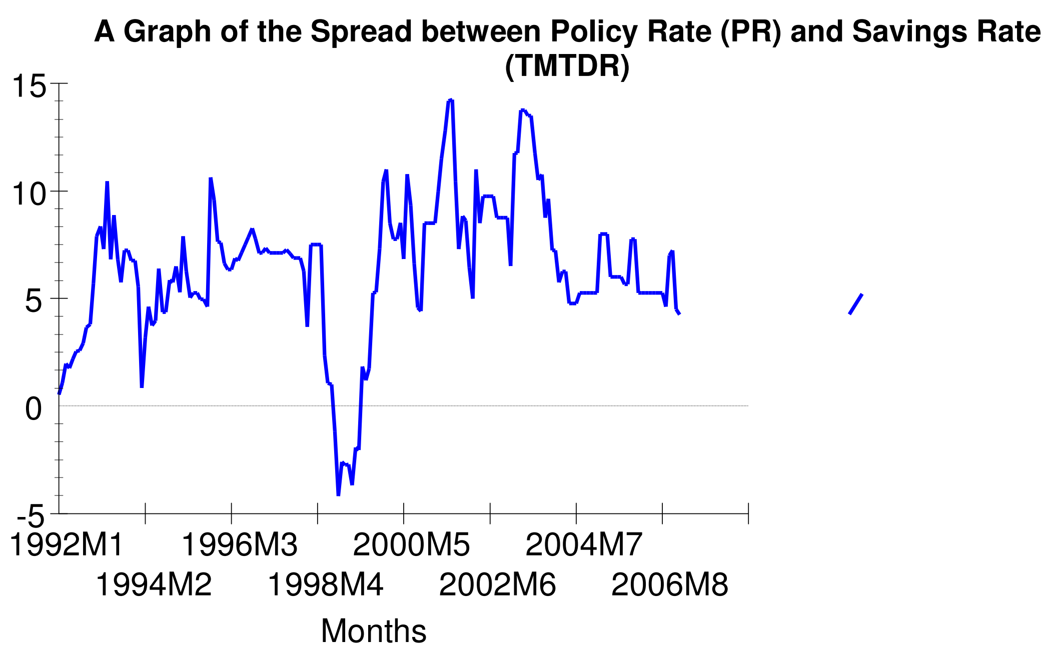



**Figure 6.3.1b**



### 6.3.2 The Single Equation Cointegration and Error Correction Method

Estimating Equation (6.1), the modified single equation cointegration and error correction model for the savings rate and the policy interest rate for the period 1992M1-2007M1, began with 12 lags of monthly changes in the savings rate and in the policy interest rate. A dummy variable is included to check for any structural breaks in the data. Upon reduction, the preferred specification is shown in Table 6.3.2a below.

**Table 6.3.2a**

Dependent variable is Change in Savings Interest Rate (DTMTDR)

Sample 1992M1-2007M1

| Regressor | Coefficient | Standard Error | T-Ratio [Prob] |
|---|---|---|---|
| C | -0.24089 | 0.28680 | -0.83991 [.402] |
| TMTDR (-1) | -0.058131 | 0.027129 | -2.1428 [.034] |
| PR (-1) | 0.052672 | 0 .026174 | 2.0124 [.046] |
| DPR (-1) | 0.37665 | 0.062015 | 6.0735 [.000] |
| DPR (-2) | 0.15678 | 0.061536 | 2.5477 [.012] |

| | | | |
|---|---|---|---|
| R-Squared | 0.33032 | R-Bar-Squared | 0.31510 |
| S.E. of Regression | 1.0829 | F-stat. F(4, 176) | 21.7030[0.000] |

**Diagnostic Tests**

| Test Statistics | LM Version | | F Version | |
|---|---|---|---|---|
| Serial Correlation | CHSQ(12)= | 13.4625[0.336] | F(12, 164)= | 1.0982[0.365] |
| Functional Form | CHSQ(1)= | 0.053600[0.817] | F(1, 175)= | 0.051839[0.820] |
| Normality | CHSQ(2)= | 287.2647[0.000] | Not applicable | |
| Heteroscedasticity | CHSQ(4)= | 4.5367[0.338] | F(1, 172)= | 1.1055[0.356] |

Note:

PR : Policy Interest Rate

TMTDR: Three Month Time Deposit Rate (The measure of savings interest rate)

Variables preceded by D are the one month differences of the respective variable in levels.

The *F*-statistic of 21.70 at the 0.01 *critical value bounds* indicates a levels relationship between the two interest rates. However, the *t*-ratio of the lag of commercial bank savings rate (2.14), being less than the critical value bound of the *t*-statistic, implies that although a levels relationship between the policy interest rate and inflation exists, the speed of convergence of the variables to equilibrium is so slow as not to be significantly different from zero. The results thus support the inference from the graphical analysis of a possible levels relationship between the two interest rates. For this period, the contemporaneous effect of a percentage point rise in the policy interest rate is a rise in the savings rate by 0.38, increasing by a further 0.16 after the second month. The insignificance of the dummy variable indicates that there is no structural break in the data set.

The long-run coefficients are derived by assuming that all variables are constant in equilibrium, with standard error in parentheses are given by:

$$\text{TMTDR} = -4.144 + \underset{(0\ .026)}{0.906\text{PR}}$$

A one percent increase in the policy interest rate raises the savings interest rate by 0.91 percentage points, which indicates a high pass-through rate[44]. However, the value is still lower than the unity reference value.

Testing whether commercial banks' response to changes in the policy interest rate depends on the level of the savings rate in the previous month (i.e. TMTDR (-1)). It is found to be significant even at 5 per cent. The results are shown in Table 6.3.2a above.

To investigate the existence of asymmetries in the response of commercial bank saving rates to the policy interest rate, a dummy (DUM) that takes a value of 1 when the policy interest rate increases and zero otherwise is interacted with the contemporaneous and first lag of the policy interest rate in differences. As shown in Table 6.3.2b, the interactive dummies are not significant, thus failing to provide a conclusion on asymmetries for the period 1992M1-2007M1.

[44] The diagnostic tests are shown in Table IX in the Appendix.

**Table 6.3.2b**

Dependent variable is Change in Savings Interest Rate

Sample 1992M2 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio [Prob] |
|---|---|---|---|
| C | -0.28355 | 0.28954 | -0.97931 [0.329] |
| TMTDR (-1) | -0.062464 | 0.027339 | -2.2848 [0.024] |
| PR (-1) | 0.055654 | 0.026372 | 2.1103 [0.036] |
| DPR (-1) | 0.33238 | 0.086492 | 3.8430 [0.000] |
| DPR (-2) | 0.15924 | 0.062047 | 2.5665 [0.011] |
| **DUMDPR** | **0.13818** | **0.093193** | **1.4827[0.140]** |
| **DUMDPR(-1)** | **0.046523** | **0.12829** | **0.36263[0.717]** |

| | | | |
|---|---|---|---|
| R-Squared | 0.33461 | R-Bar-Squared | 0.31153 |
| S.E. of Regression | 1.0843 | F-stat. F(6, 173) | 14.4994[0.000] |

**Diagnostic Tests**

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ(12)= 13.2304[0.353] | F(12, 161)= 1.0644[0.394] |
| Functional Form | CHSQ(1)= 0.38980[0.532] | F(1, 172)= 0.37328[0.542] |
| Normality | CHSQ(2)= 290.7027[0.000] | Not applicable |
| Heteroscedasticity | CHSQ(6)= 5.9111[0.433] | F(6, 167)= 0.94507[0.464] |

Note:

PR : Policy Interest Rate

TMTDR: Three Month Time Deposit Rate (The measure of savings interest rate)

DUMDPR: Dummy variable is interacted with the contemporaneous policy interest rate

DUMDPR (-1): Dummy variable is interacted with the first lag of the policy interest rate in differences

Variables preceded by D are the one month differences of the respective variable in levels.

The hypothesis that policy transmission in Ghana during these periods was through moral suasion is also tested. This involves running a regression of the logarithm of real private sector credit (LLRCPS) and the policy interest rate (PR) using the *modified* co-integration and error correction methodology. A binary dummy variable, which is 0 from 1992M1 -2002M3 and 1 from 2002M4-2007M1 is included to check for structural breaks in the data. Table 6.3.2c shows the preferred specification after dropping insignificant terms.

**Table 6.3.2c**

Dependent variable is DLLRCPS

Sample from 1992M1 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| C | 0.015252 | 0.012283 | 1.2417[0.216] |
| **PR (-1)** | **-0.0002519** | **0.0004026** | **-0.62565[0.532]** |
| DLLRCPS (-7) | 0.18077 | 0.067354 | 2.6839[0.008] |
| DLLRCPS (-12) | -0.14999 | 0.064505 | -2.3252[0.021] |

| | | | |
|---|---|---|---|
| R-Squared | 0.061610 | R-Bar-Squared | 0.045705 |
| S.E. of Regression | 0.050583 | F-stat. F(5, 175) | 3.8736[0.010] |

**Diagnostic Tests**

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ(12)= 9.4806[0.661] | F(12, 165)= 0.76002[0.691] |
| Functional Form | CHSQ(1)= 1.9598[0.162] | F(1, 176)= 1.9266[0.167] |
| Normality | CHSQ(2) = 751.6261[0.000] | Not applicable |
| Heteroscedasticity | CHSQ(1)= 0.037123[0.847] | F(1, 179)= 0.036721[0.848] |

Note:

PR : Policy Interest Rate

LLRCPS: The deviation from trend of the log or real private sector credit (The measure of output gap)

Variables preceded by D are the one month differences of the respective variable in levels.

The table shows that real private sector credit responds negatively and insignificantly to the policy stance in levels. The absence of a relationship in levels is interpreted as indicating an absence of moral suasion for policy conduct over the period 1992M1-2007M1.

### 6.3.3 A VECM Framework.

To check whether the variables are cointegrated or spuriously related, we need to test if they are stationary or of unit roots. The formal approaches employed as in Chapter 5, for testing for stationarity, are the Dickey Fuller (DF) and the augmented Dickey Fuller (ADF) tests and the Ng-Perron tests. The results from the formal tests for stationarity are shown in Tables 6.3.3a and 6.3.3b below.

**Table 6.3.3a**

| **Test With Intercept** | | **Ng-Perron** | | | |
|---|---|---|---|---|---|
| **Variable** | **ADF Test** | **$MZ_a$** | **$MZ_t$** | **MSB** | **$MP_T$** |
| Policy rate | -1.217 | -2.229 | -1.016 | 0.456 | 10.693 |
| Three Months Time Deposit Rate | -1.185 | -3.387 | -1.213 | 0.358 | 7.198 |
| **Test With Intercept and Trend** | | | | | |
| Policy Rate | -2.185 | -2.589 | -1.003 | 0.387 | 30.554 |
| Three Months Time Deposit Rate | -1.699 | -4.069 | -1.347 | 0.331 | 21.529 |

Comparing the values in Table 6.3.3a with the critical values in Table 6.3.3b below shows that the policy rate and the three months time deposit rate (savings rate) were difference stationary variables i.e. they are I(1) variables.

**Table 6.3.3b**

**Critical Values (Tests with Intercept)**

| | $\tau_\tau$ | $MZ_a$ | $MZ_t$ | MSB | $MP_T$ |
|---|---|---|---|---|---|
| 5% | -2.878 | -8.100 | -1.980 | 0.233 | 3.170 |
| 10% | -2.575 | -5.700 | -1.620 | 0.275 | 4.450 |

**Critical Values (Tests with Intercept and Trend)**

| | $\tau_\tau$ | $MZ_a$ | $MZ_t$ | MSB | $MP_T$ |
|---|---|---|---|---|---|
| 5% | -3.435 | -17.300 | -2.9100 | 0.1680 | 5.480 |
| 10% | -3.141 | -14.200 | -2.620 | 0.185 | 6.670 |

Note: The critical values for the ADF tests have been taken from Fuller (1976, p.373), and Dickey and Fuller, (1981, p.1062) and those for the Ng-Perron tests from Ng and Perron (2001).

We use the Johansen cointegration test to determine if the variables are cointegrated. The Johansen method, unlike the Engle-Granger approach, allows the testing of hypotheses by considering them effectively as restrictions on the cointegrating vector. The test developed by Johansen (1991) is given by the VAR equation below:

$$\Delta y_t = \prod y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots + \Gamma_{k-1} \Delta y_{t-(k-1)} + \upsilon_t \qquad (6.4)$$

where $y_t$ is a $p$-dimensional vector of the variables. If $\prod$ is of zero rank[45], there is no cointegration, otherwise the rank will give the number of cointegrating vectors.

Starting with VAR (12) of policy interest rate (PR) and commercial bank savings rate (TMTDR), the AIC and SBC model selection criteria pointed to VAR(1) as the appropriate description of the data (see Appendix Table V). Specifying the cointegrating relationship without a time trend, both the trace and maximal eigen

[45] That is all the eigenvalues are not significantly different from zero.

value tests suggest the existence of one cointegrating vector at the 5 per cent level for the period 1992M1-2007M1. The test results are shown in Table 6.3.3c.

**Table 6.3.3c**

**Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 1.

List of variables included in the cointegrating vector:

TMTDR PR

List of eigenvalues in descending order:

0.11629 0.0013626

| Null | Alternative | $\lambda_{max}$ Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r = 1 | 22.3766 | 14.8800 | 12.9800 |
| r<= 1 | r = 2 | 0.24681 | 8.0700 | 6.5000 |

**Cointegration LR Test Based on Trace of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 1.

List of variables included in the cointegrating vector:

TMTDR PR

List of eigenvalues in descending order:

0.11629 0.0013626

| Null | Alternative | $\lambda_{trace}$ Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r>= 1 | 22.6234 | 17.8600 | 15.7500 |
| r<= 1 | r = 2 | 0.24681 | 8.0700 | 6.5000 |

The long-run relationship between commercial bank savings interest rate and the policy rate is given by:

$$TMTDR = -3.241 + \underset{(0.0249)}{0.891}PR$$

(see Appendix Table VII for the diagnostic tests)

The estimates which are similar to the results found in the error correction approach suggest that: (i) the policy interest rate is positively correlated with the commercial bank savings rate, and (ii) 89 per cent of the shock to the policy interest rate is passed-through to the savings rate in the long run.

Having established that the savings interest rate (TMTDR) is cointegrated with the policy rate (PR), the short-run dynamics of the model can be exploited using the Granger representation theorem. According to this theorem, if a set of variables is cointegrated (that is, if there is a long-run relationship between them) then the short-run dynamics of the long-run relationship can be described by an error-correction model as follows:

$$DTMTDR = \beta_0 + \sum_{i=0}^{n} \beta_{1i} DPR + \sum_{i=1}^{n} \beta_{2i} DTMTDR_{t-i} + \beta_3 ECC_{t-1} + \varepsilon_t \qquad (6.5)$$

where *EEC* is the error correction component and n is set equal to 1, as the AIC and SBC model selection criteria point to VAR(1) as the appropriate description of the data. The *EEC* is derived from the long-run relationship and is given by:

$$ECC_t = TMTDR_t - \hat{TMTDR}_t \qquad (6.6)$$

where $\hat{TMTDR}_t$ is the fitted value of the actual value of $TMTDR_t$. The results are showed below in Table 6.3.3d.

**Table 6.3.3d**

Error correction model for variable PR estimated by OLS based on cointegrating VAR (1). Dependent variable is Change in savings rate, DTMTDR

Sample for estimation from 1992M2 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio [Prob] |
|---|---|---|---|
| C | -0.012762 | 0.080372 | -0.15878[0.874] |
| DPR(-1) | 0.34974 | 0.067730 | 5.1638[0.000] |
| DTMTDR(-1) | 0.40733 | 0.12459 | 3.2694[0.001] |
| **ECC(-1)** | **-0.57651** | **0.14575** | **-3.9555[0.000]** |

| | | | |
|---|---|---|---|
| R-Squared | 0.33827 | R-Bar-Squared | 0.32314 |
| S.E. of Regression | 1.0751 | F-stat. F(4, 175) | 22.3643[0.000] |

**Diagnostic Tests**

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ (12) = 11.5900[0.479] | F (12, 163) = 0.93481[0.514] |
| Functional Form | CHSQ (1) = 0.14768[0.701] | F (1, 174) = 0.14288[0.706] |
| Normality | CHSQ (2) = 248.4794[0.000] | Not applicable |
| Heteroscedasticity | CHSQ (1) = 0.0064713[0.936] | F (1, 174) = 0.00626[0.937] |

Note:

PR : Policy Interest Rate

TMTDR: Three Month Time Deposit Rate (The measure of savings interest rate)

EEC: Error Correction Term

Variables preceded by D are the one month differences of the respective variable in levels.

The inclusion of the error term in the equation allows the integration of short term dynamics with the long term equilibria. That is the error correction term represents the short-run response necessary to move the system back towards long-run equilibrium. The coefficient for *EEC (-1)* indicates a fairly rapid adjustment of savings interest rate towards its equilibrium value. That is, there is a 57.65 per cent feedback from the previous period into the short-run dynamics process.

Figures 6.3.3 A and 6.3.3 B below show impulse responses over a sixty month horizon. The plot indicates that a one-standard-error shock to the policy interest rate (equivalent to a 1.30 percentage point rise) shows no strong sign of convergence over the forecast horizon. The contemporaneous response of the savings interest rate is a rise of 0.2 percentage points. Over the sixty month horizon, the response of the savings rate increases to about six times the magnitude of the impact effect by the first twenty months; but like the policy interest rate it does not show strong evidence of convergence. Over the forecast horizon, the two interest rates depict a slowly narrowing margin of divergence.

However, the plot indicates that a one-standard-error shock to the savings interest rate (equivalent to a 1.10 percentage point rise) shows a fall over the first thirty five (35) months period. The contemporaneous response of the policy interest rate is a rise of about 0.2 percentage points.

**Figure 6.3.3 A**

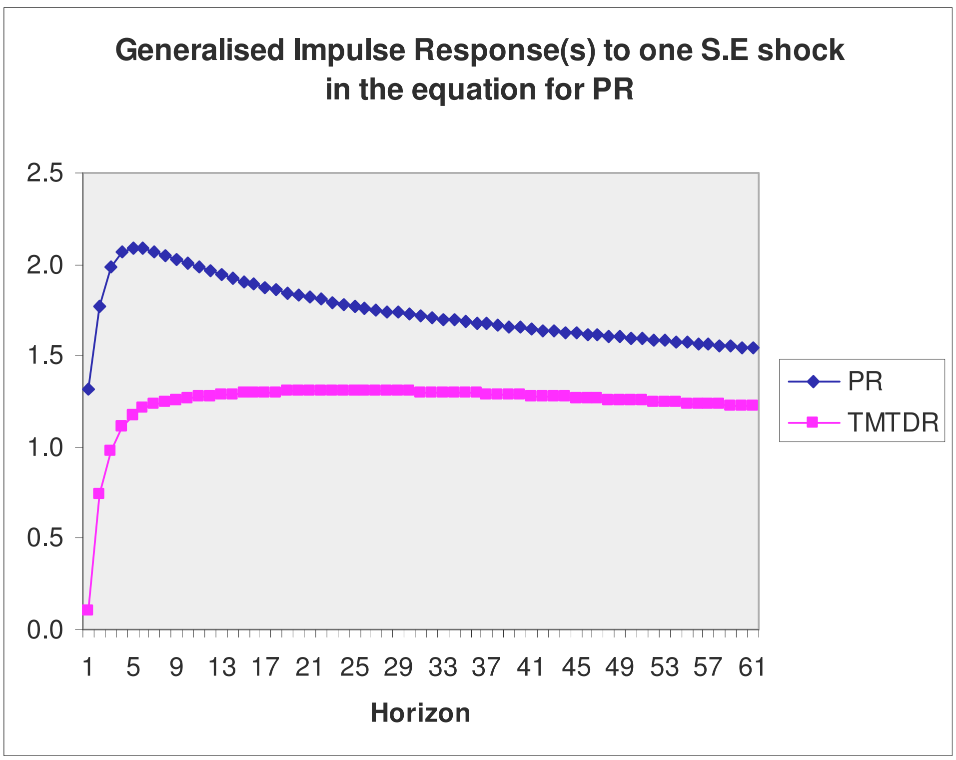
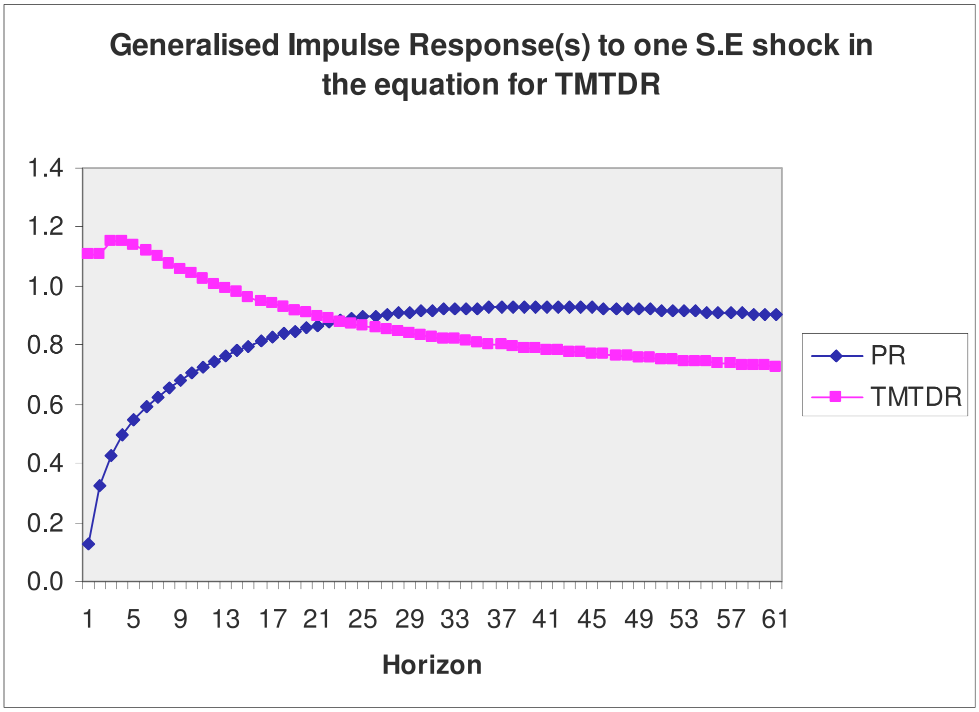


**Figure 6.3.3 B**




## 6.4 Summary and Conclusion

The techniques used to analyse the responsiveness of the savings interest rate to the policy interest rate showed high responsiveness over the period 1992M1-2007M1. Estimating for the sample period showed evidence of level relationship between the two interest rates. Both the single equation error correction approach and the pass-through process within a VECM framework for the savings interest rate and the policy interest rate indicate a fairly rapid adjustment of the savings interest rate towards its equilibrium value.

The long-run pass-through process shows high responsiveness over the sample period. A pass-through value of 0.90 suggests that the policy interest rate is positively correlated with the commercial bank savings rate, and about 90 per cent of the shock to the policy interest rate is passed-through to the savings rate in the long run. However, this value is lower than unity, which is the reference value in the empirical literature.

Assessing the efficiency of monetary policy on the basis of the strength of responsiveness of commercial bank retail rates, particularly the saving rate to policy interest rates, the research concludes that with a near unity pass-through rate in the long-run, monetary policy was largely effective in influencing the savings rate in Ghana over the period 1992M1-2007M1.

There was an absence of an asymmetric response over the sample period and there was no evidence that commercial banks' responses to changes in the policy rate depended on the level of savings in the previous month. Investigating evidence of the use of moral suasion to affect liquidity conditions, none was found.

The results therefore indicate some long-run effectiveness of monetary policy in influencing commercial bank retail rates between 1992M1-2007M1 which is the initial phase of the transmission process.

Chapter 7 now provides a fuller assessment of monetary policy effectiveness, by the transmission mechanism approach, which requires an investigation into how other important variables that are either the final objective of policy or the conduit through which the final objective of policy is attained, behave in response to monetary policy impulses in the transmission mechanism.

# Chapter 7

# Monetary Transmission Mechanism Estimates

## 7.1 Introduction

A fuller assessment of the transmission mechanism is the aim of this chapter. Chapter 6 assessed Ghana's monetary policy effectiveness by evaluating the responsiveness of the commercial bank retail rates to changes in the policy interest rate. While informative, it can be argued that its usefulness is limited because of its focus only on the initial phase of the transmission process. A fuller assessment of monetary policy effectiveness, by the transmission mechanism approach, would require an investigation into how other important variables that are either the final objective of policy or the conduit through which the final objective of policy is attained, behave in response to monetary policy impulses. This fuller assessment is the main objective of this chapter. In meeting this objective, the chapter also provides information that holds promise to facilitating the design and implementation of monetary policy itself. In particular, it provides a view on the optimal timing of policy actions. Furthermore, the chapter cross-references the results it finds with those from the single equation models of, first, the monetary policy reaction functions of Chapter 5 and, second, the responsiveness of the commercial bank savings interest rate to the policy interest rate analysis of Chapter 6. A key assumption underlying the estimations in Chapter 5 and 6 is that the information variable(s) are at least weakly exogenous (see Appendix Table IX).Chapter 7, which relaxes this assumption by recognising the simultaneity amongst the variables, should offer a means of establishing the robustness or otherwise of the earlier results.

The earlier review of the literature on the monetary transmission mechanism (in Chapter 4) indicated a near consensus on the effect of a contractionary monetary policy shock that can be summarised as follows. Interest rates rise initially; and monetary aggregates fall. This rise in interest rates is subsequently reversed. Then, for up to about six months following the policy tightening, there is an absence of effect, or more customarily, an initial rise in output (the output puzzle). Output subsequently falls, as theory predicts, a fall that remains sustained for about two years. Prices, usually after some initial rise (the price puzzle) that can extend to two years, decline in line with theoretical predictions.

Also the literature holds that where a variable that captures future inflation is included in the VAR, the price puzzle is eliminated. These stylised facts are the benchmark for analysing the empirical results of this chapter. Following our estimations, if the signs and shapes of the impulse responses follow the findings of the literature, the faster the speed of transmission of policy impulses to the variables, the more effective we deem monetary policy to be.

Beyond this introduction, the chapter consists of two sections and a conclusion. Section 7.2 presents the empirical framework. Section 7.3 presents the results of the monetary policy transmission and Section 7.4 concludes the chapter.

## 7.2 Empirical Technique and Data

### 7.2.1 Model Specification

The analysis in this chapter uses a vector autoregressions and vector error correction model (VAR/VECM) as the empirical framework. The advantages of the VAR/VECM methodology include: (i) the explicit recognition of simultaneity between monetary policy and macroeconomic development, i.e. the dependence of monetary policy on macroeconomic variables (the policy reaction function) as well as the dependence of economic variables on monetary policy; and (ii) minimal restrictions on how shocks affect the economy. We employ a standard VAR model. This model arises from a linear, simultaneous equation system between the endogenous and exogenous variables of the form in Equation (7.1).

$$Ax_t = C\,(L)x_{t-1}+Dz_t \qquad (7.1)$$

$x_t$ is a vector of endogenous variables and $z_t$ a vector of exogenous variables (assumed to consist of unobservable variables which are interpreted as disturbances to the structural equations). The elements of the matrix $A$ are the structural parameters on the contemporaneous endogenous variables and $C(L)$ is the $k^{th}$ degree matrix polynomial in the lag operator *L*. The matrix *D* measures the contemporaneous response of endogenous variables to exogenous variables.

The reduced form for this system is:

$$x_t = A^{-1}\, C\,(L)x_{t-1} + A^{-1}\, Dz_t \qquad (7.2)$$

A particular structural specification of the error term, $z$, is required to obtain a VAR representation. Two alternative and commonly used assumptions are that the shocks have temporary or permanent effects. If shocks have temporary effects, $z_t$ equals $\varepsilon_t$, a serially uncorrelated vector white noise process. Alternatively, $z$ can be modelled as a unit root process. When modelled as a unit root process, z equals past and present realisations of $\varepsilon$, hence shocks to $z$ are permanent.

The analysis undertaken in this chapter assumes that the exogenous shocks have only temporary effects i.e. $z_t$ equals $\varepsilon_t$, a serially uncorrelated vector white noise process. For simplicity, it is important that our VAR has a zero mean process for all time, a continuous time random process, so that Equation (7.2) is re-written as:

$$x_t = B(L)x_{t-1} + e_t \qquad (7.3)$$

where $B(L) = A^{-1}\, C\,(L)$ and $e_t = A^{-1}\, D\varepsilon_t$. The equation system in (7.3), an unrestricted VAR in levels, is the VAR representation of the structural model employed. The last term in this expression is serially uncorrelated, and each variable is a function of lagged values of all the variables. The VAR coefficient matrix, *B(L)*, is a function of the contemporaneous and dynamic structural parameters. Identification is achieved by a careful Choleski ordering of the variables to conform to a likely structural model of the economy.

A monetary policy shock from the estimated recursive VAR is identified with the disturbance term of the central bank reaction function equation of the form:

$$I_t = f(\Omega_t) + \varepsilon^i_t \qquad (7.4)$$

where, $I_t$ is the monetary policy instrument, $f$ is the linear function, $\Omega_t$ is the information set for the formulation of policy, and $\varepsilon^i_t$ is the serially uncorrelated monetary policy shock that is orthogonal to the elements of $\Omega_t$. The orthogonality restriction on $\varepsilon^i_t$ is obtained by the order imposed on the variables in the VAR. This recursive identification justifies estimating the residual $\varepsilon^i_t$ as the residual in an ordinary least squares regression of $I_t$ on $\Omega_t$ . Conditional on the ordering chosen, the dynamic response of a variable to a monetary policy shock is measured by the coefficients in the regression of the variable on current and lagged values of the fitted residuals in Equation (7.4).

The research estimates three specifications of the VAR/VECM due to degrees of freedom problems. This is to ensure that inferences on the primary variables of interest are not influenced by this problem. The first VAR/VECM specification (the base VAR) contains the policy interest rate, output gap, inflation, and the exchange rate. The first extension adds the commercial bank savings interest rate. This inclusion is to confirm the results from the bivariate analysis of the responsiveness of the savings interest rate to the policy interest rate undertaken in Chapter 6, when other important variables are controlled for. Given the failure to find the expected level of responsiveness of the savings interest rate to the policy interest rate, and hypothesising the finding could have been driven by the failure to control for the effect of important variables, the inclusion of such variables in the VARs in this chapter serves as a check for the robustness of the previous findings. The third VAR specification further extends the second by introducing broad money. Given its role as an intermediate target of monetary policy, and therefore its primary importance for monetary policy conduct in Ghana, this inclusion is to investigate its actual importance in the monetary policy process. This is done by first, investigating its response to policy interest rate shocks; and, second, investigating the effect of a shock to it on the policy interest rate and the other variables in the VAR/VECM. The deterministic variables included in the three VAR specifications are a constant and a time trend.

In the literature, the usual considerations for variable ordering are assumptions about: (i) the relative levels of variable exogeneity/endogeneity, (ii) lags in data generation, (iii) the speed with which variables respond to shocks, and/or (iv) the relative ease with which variables can be adjusted. When a variable is ordered first, it is assumed that the variable is the most exogenous/least endogenous, least responsive to shocks, and any contemporaneous feedback from other variables in the VAR to it is absent. For the last ordered variable, it is assumed to be the least exogenous, most responsive, and it responds contemporaneously to other variables.

Following the predominant ordering adopted in work in this area, for the base VAR/VECM, we order the policy interest rate last i.e. assume the policy interest rate is least exogenous. When extended, the policy interest rate is ordered before the commercial bank savings interest rate and real broad money. The other consideration is the order imposed on the non-policy variables in the VAR. The economic activity variable - output gap - is assumed least responsive to shocks, so ordered first. Ordered second is inflation. Ordering inflation after output gap is underpinned by the Phillips Curve relationship that decreases/increases in output leads to decreases/increases in inflation with some lag. The exchange rate is ordered third, given the timeliness of its generation and the relative ease with which it adjusts. Thus, the base VAR we estimate has its variables ordered as follows: the output gap *(LLRCPS)*, inflation *(ANF1M)*, real exchange rate *(LREER)*, and the policy instrument *(PR)*.

When the base VAR is extended by the commercial bank savings interest rate, the variables are ordered as follows: (*LLRCPS), (ANF1M), (LREER), (PR), and (TMTDR)*. Ordering *(TMTDR)* after *(PR)* is based on the assumption that the savings interest rate responds to the policy interest rate and not vice-versa. When extended by broad money *(ANRMO21M)*, the ordering is as follows: (*LLRCPS), (ANF1M), (LREER), (PR), (TMTDR)*, and *(ANRMO21M)*. Placing broad money after the policy interest instrument is explained by the lag in the generation of broad money data. This ordering is consistent with for example, Bernanke and Gertler (1995) and Morsink and Bayoumi (2001).

Whilst ordering the variables as discussed, the research recognises that some strands of the literature place the policy interest rate first. Given that the issue of ordering is still subject to some debate, we present the generalised impulse response functions (GIRF), rather than orthogonalised impulse responses (OIRF). The advantage of the

GIRF is its generation of impulse response functions that are unique. That is, unlike the OIRF counterparts, GIRF are invariant to the ordering of variables.

### 7.2.2 Sample and Estimation Strategy

The sample period corresponds to the period of indirect implementation of monetary policy: 1992M1- 2007M1. The Treasury bill rate is used as a proxy for the policy instrument until March 2002 and then the prime rate for April 2002 - January 2007. In March 2002 the Central Bank started using the prime rate as its monetary policy instrument.

We are interested in the fine timing of responses to a monetary policy shock; therefore, the data used have a monthly frequency. In the VAR/VECM, a policy shock in all cases corresponds to a contractionary monetary policy that is measured by a positive one-standard error increase in the policy interest rate. Output gap is measured by the deviation of real private sector credit from linear trend. Inflation is the annualised one-month CPI inflation. The exchange rate is measured by the log of the real effective exchange rate (where an increase means an appreciation). Broad money is deflated by CPI and the logarithm of the real value taken.

From a VAR (12), the optimal lag using the standard model selection criteria - AIC and/or the SBC is selected, while being mindful of the need to avoid serial correlation in the residuals (see Appendix Table VI). The optimal lag of the unrestricted VAR in levels is chosen following the general-to-specific approach. The horizon of the impulse response is set at 60 months. All variables, with the exception of the interest rates, are in logs. Furthermore, while the policy interest rate, the commercial bank savings interest rate, and inflation are in percentage points and annualised, the real exchange rate, real broad money, and output gap are not. For the real exchange rate, real broad money, and the output gap, therefore, an impulse response value of 0.001 equals 0.1 per cent deviation from the baseline; while for the interest rates and inflation, an impulse response coefficient of 0.1 implies a 0.1 percentage point deviation from the baseline level (already in percentages).

## 7.3 Monetary Policy Transmission

Having found that the variables are I(1) from Chapter 5, impulse response functions from three unrestricted vector error correction models (VECM) are estimated in this section to deduce the transmission of monetary policy. This section also estimates policy interest rate responses to shocks to variables and compares the findings with those found from the similar analysis, in Chapter 5, that used single equation models. This section also compares the responsiveness of the savings interest rate to the policy rate inferred from the analysis in this section with that of Chapter 6. In addition, the impacts of shocks to all variables are shown, and the results for key variables are discussed.

We use the Johansen cointegration test to determine if the variables are cointegrated. The Johansen method, unlike the Engle-Granger approach, allows the testing of hypotheses by considering them effectively as restrictions on the cointegrating vector. The test developed by Johansen (1991) is given by the VAR equation below:

$$\Delta y_t = \prod y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \ldots + \Gamma_{k-1} \Delta y_{t-(k-1)} + \upsilon_t \qquad (7.5)$$

where $y_t$ is a $p$-dimensional vector of the variables. If $\prod$ is of zero rank[46], there is no cointegration; otherwise the rank will give the number of cointegrating vectors.

### 7.3.1 Results from the Base VECM

Starting with VAR (12) of output gap *(LLRCPS)*, inflation *(ANF1M)*, real exchange rate *(LREER)*, and the policy instrument *(PR)*, the AIC and SBC model selection criteria point to VAR(2) as the appropriate description of the data (see Appendix Table VI A). Specifying the cointegrating relationship without a time trend, both the trace and maximal eigen value tests suggest the existence of one cointegrating vector at the 5 per cent level for the period 1992M1-2007M1. The test results are shown in Table 7.3.1A.

[46] That is all the eigenvalues are not significantly different from zero.

**Tables 7.3.1A**

**Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 2.

List of variables included in the cointegrating vector:

LLRCPS ANF1M LREER PR

List of eigenvalues in descending order:

0.29970 0.048350 0.014344 0.0013565

| Null | Alternative | Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r = 1 | 64.4807 | 23.9200 | 21.5800 |
| r<= 1 | r = 2 | 8.9700 | 17.6800 | 15.5700 |
| r<= 2 | r = 3 | 2.6150 | 11.0300 | 9.2800 |
| r<= 3 | r = 4 | 0.24568 | 4.1600 | 3.0400 |

**Cointegration LR Test Based on Trace of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 2.

List of variables included in the cointegrating vector:

LLRCPS ANF1M LREER PR

List of eigenvalues in descending order:

0.29970 0.048350 0.014344 0.0013565

| Null | Alternative | Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r>= 1 | 76.3114 | 39.8100 | 36.6900 |
| r<= 1 | r>= 2 | 11.8307 | 24.0500 | 21.4600 |
| r<= 2 | r>= 3 | 2.8607 | 12.3600 | 10.2500 |
| r<= 3 | r = 4 | 0.24568 | 4.1600 | 3.0400 |

Having established that the variables are cointegrated, the short-run dynamics of the model can be exploited using the Granger representation theorem. According to this theorem, if a set of variables is cointegrated (that is, if there is a long-run relationship between them) then the short-run dynamics of the long-run relationship can be described by an error-correction model as follows:

$$DPR = \beta_0 + \sum_{i=0}^{n} \beta_{1i} DLREER + \sum_{i=0}^{n} \beta_{2i} DANF1M + \sum_{i=0}^{n} \beta_{3i} DLLRCPS$$
$$+ \sum_{i=1}^{n} \beta_{4i} DPR_{t-i} + \beta_5 ECC_{t-1} + \varepsilon_t \qquad (7.6)$$

where *ECC* is the error correction component and n is set equal to 2 as the AIC and SBC model selection criteria pointed to VAR(2) as the appropriate description of the data. The *EEC* is derived from the long-run relationship and is given by:

$$ECC_t = PR_t - \hat{PR}_t \qquad (7.7)$$

where $\hat{PR}_t$ is the fitted value of the actual value of $PR_t$. The results are shown below in Table 7.3.1A.

**Table 7.3.1B**

Error correction model for variable PR estimated by OLS based on cointegrating VAR (2). Dependent variable is change in policy rate, DPR

Sample for estimation from 1992M2 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| DLLRCPS1 | 1.0615 | 1.7729 | 0.59873[0.550] |
| DANF1M1 | -0.0003883 | 0.0061215 | -0.063431[0.949] |
| DLREER1 | -2.6089 | 3.8376 | -0.67982[0.498] |
| DPR1 | 0.33799 | 0.071088 | 4.7546[0.000] |
| **ECC(-1)** | **2.4476** | **1.3160** | **1.8599[0.065]** |

| | | | | |
|---|---|---|---|---|
| R-Squared | 0.16511 | R-Bar-Squared | | 0.14613 |
| S.E. of Regression | 1.3160 | F-stat. | F(4, 176) | 8.7015[0.000] |
| DW-statistic | 2.0263 | | | |

**Diagnostic Tests**

| Test Statistics | LM Version | | F Version | |
|---|---|---|---|---|
| Serial Correlation | CHSQ(12)= | 9.7682[0.636] | F(12, 164)= | 0.77964[0.671] |
| Functional Form | CHSQ(1)= | 0.59355[0.441] | F(1, 175)= | 0.57576[0.449] |
| Normality | CHSQ(2)= | 199.6719[0.000] | Not applicable | |
| Heteroscedasticity | CHSQ(1)= | 0.30682[0.580] | F(1, 179)= | 0.30394[0.582] |

Note:

DPR = PR-PR (-1)

DLLRCPS1 = LLRCPS (-1)-LLRCPS (-2)

DANF1M1 = ANF1M(-1)-ANF1M(-2)

DLREER1 = LREER(-1)-LREER(-2)

DPR1 = PR (-1)-PR (-2)

ECC: Error Correction Term

The results show that only the lagged difference in policy rate is significant at 5 per cent in the short-run. The error correction term represents the short-run response necessary to move the system back towards long-run equilibrium. The positive coefficient for *EEC (-1)* indicates that in the previous period the equilibrium value of the policy rate exceeded its actual value or actual policy rate fell short of equilibrium. The policy rate should increase towards its equilibrium value. That is, there is a 2.45 per cent feedback from the previous period into the short-run dynamics process.

Figure 7.3.1A below shows variables' response from a one-standard-error shock to the policy interest rate (equivalent to a 1.4 percentage point rise) from the estimated VECM (2) model (see Appendix Table VI A). The impulse indicates that while the policy interest rate response throughout the horizon and inflation response in the initial fifteen (15) months are significant, those of output gap and real exchange rate are insignificant. Inflation falls in the first fifteen (15) months and stabilises in the ensuing forty five (45) months. In line with the finding from the single equation model of Chapter 5, Figures 7.3.1B, C and D show insignificant interest rate responses to real exchange rate, inflation and output gap.

**Figure 7.3.1A**

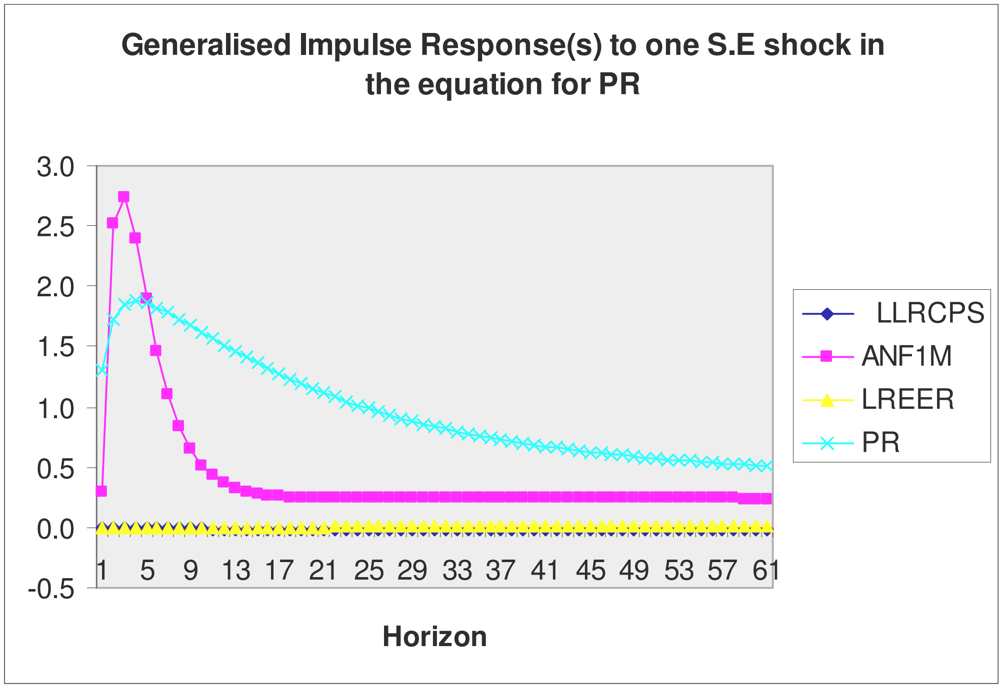



**Figure 7.3.1B**

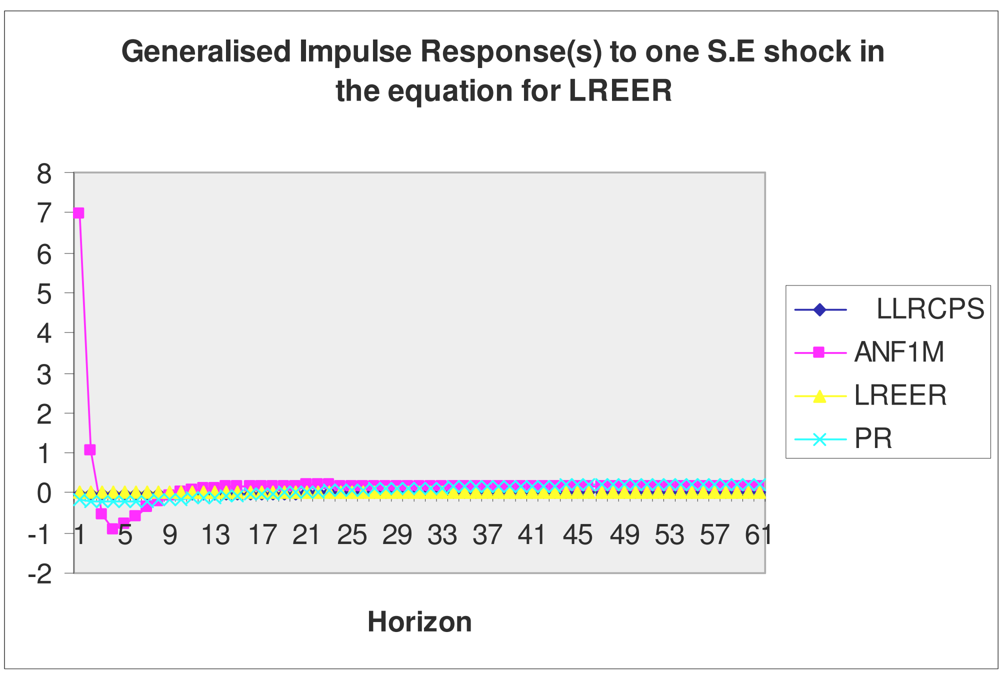


**Figure 7.3.1C**

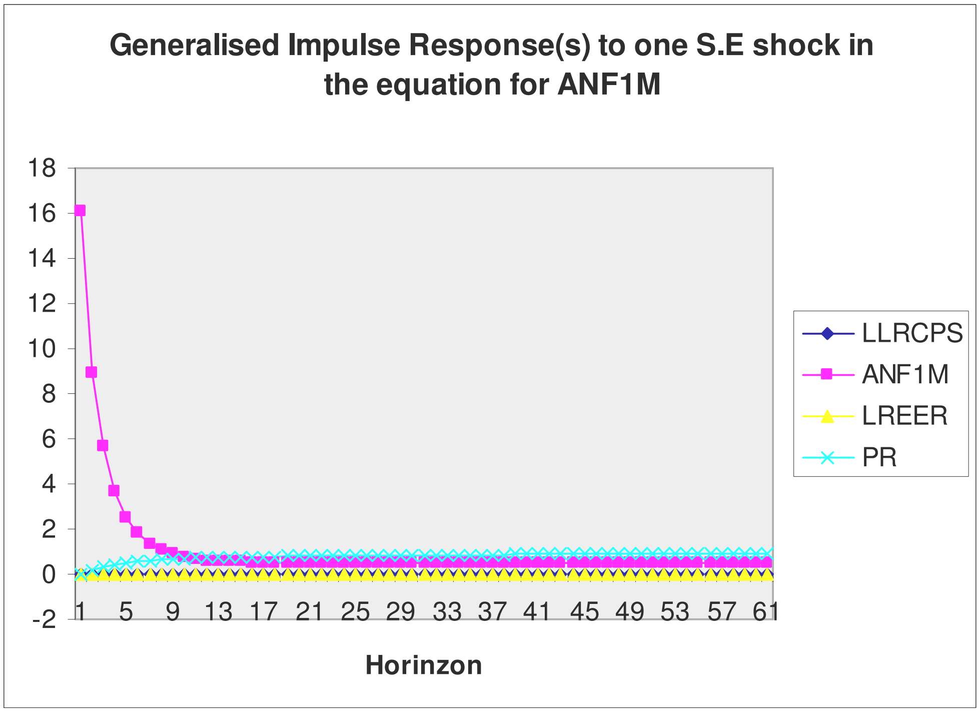
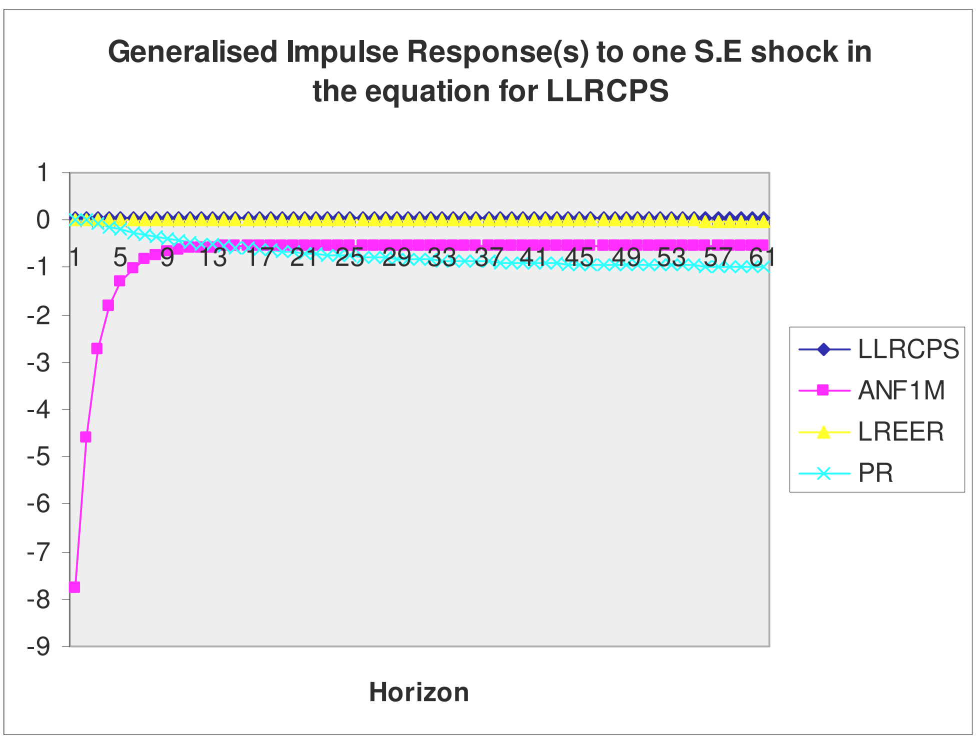



**Figure 7.3.1D**



### 7.3.2 Results from the Extended VECM

Extending the base VECM by the savings interest rate (TMTDR) and starting with VAR (12), the AIC and SBC model selection criteria point to VAR(2) as the appropriate description of the data (see Appendix Table VI B). Specifying the cointegrating relationship without a time trend, both the trace and maximal eigen value tests suggest the existence of one cointegrating vector at the 5 per cent level for the period 1992M1-2007M1. The test results are shown in Table 7.3.2A.

**Tables 7.3.2A**

**Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 2.

List of variables included in the cointegrating vector:

LLRCPS ANF1M LREER PR TMTDR

List of eigenvalues in descending order:

0.29142 0.072903 0.048630 0.015365 0.0026854

| Null | Alternative | Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r = 1 | 62.3532 | 29.9500 | 27.5700 |
| r<= 1 | r = 2 | 13.7012 | 23.9200 | 21.5800 |
| r<= 2 | r = 3 | 9.0232 | 17.6800 | 15.5700 |
| r<= 3 | r = 4 | 2.8026 | 11.0300 | 9.2800 |
| r<= 4 | r = 5 | 0.48672 | 4.1600 | 3.0400 |

**Cointegration LR Test Based on Trace of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 2.

List of variables included in the cointegrating vector:

LLRCPS ANF1M LREER PR TMTDR

List of eigenvalues in descending order:

0.29142 0.072903 0.048630 0.015365 0.0026854

| Null | Alternative | Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r>= 1 | 88.3670 | 59.3300 | 55.4200 |
| r<= 1 | r>= 2 | 26.0137 | 39.8100 | 36.6900 |
| r<= 2 | r>= 3 | 12.3126 | 24.0500 | 21.4600 |
| r<= 3 | r>= 4 | 3.2893 | 12.3600 | 10.2500 |
| r<= 4 | r = 5 | 0.48672 | 4.1600 | 3.0400 |

Extending equation 7.6 by the commercial bank savings rate, the short-run dynamics of the long-run relationship can be described by an error-correction model as follows:

$$DPR = \beta_0 + \sum_{i=0}^{n} \beta_{1i} DLREER + \sum_{i=0}^{n} \beta_{2i} DANF1M + \sum_{i=0}^{n} \beta_{3i} DLLRCPS + \sum_{i=0}^{n} \beta_{4i} DTMTDR + \sum_{i=1}^{n} \beta_{5i} DPR_{t-i} + \beta_6 ECC_{t-1} + \varepsilon_t \tag{7.8}$$

where *ECC* is the error correction component and n is set equal to 2 as the AIC and SBC model selection criteria point to VAR(2) as the appropriate description of the data. The results are shown below in Table 7.3.2B.

**Table 7.3.2B**

Error correction model for variable PR estimated by OLS based on cointegrating VAR (2). Dependent variable is Change in policy rate, DPR

Sample for estimation from 1992M2 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| DLLRCPS1 | 0.97269 | 1.7730 | 0.54862[0.584] |
| DANF1M1 | -0.0000002357 | 0.0061034 | -0.00003862[1.00] |
| DLREER1 | -2.0469 | 3.8454 | -0.53229[0.595] |
| DPR1 | 0.31452 | 0.073297 | 4.2911[0.000] |
| DTMTDR1 | 0.10186 | 0.078098 | 1.3042[0.194] |
| **ECC(-1)** | **2.1569** | **1.3139** | **1.6416[0.102]** |

| | | | |
|---|---|---|---|
| R-Squared | 0.17247 | R-Bar-Squared | 0.14882 |
| S.E. of Regression | 1.3139 | F-stat. F( 5, 175) | 7.2944[0.000] |
| DW-statistic | 1.9840 | | |

**Diagnostic Tests**

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ( 12)= 9.0757[0.696] | F( 12, 163)= 0.71705[0.733] |
| Functional Form | CHSQ( 1)= 0.84744[0.357] | F( 1, 174)= 0.81849[0.367] |
| Normality | CHSQ( 2)= 205.7348[0.000] | Not applicable |
| Heteroscedasticity | CHSQ( 1)= 0.61225[0.434] | F( 1, 179)= 0.60754[0.437] |

Note:

DPR = PR-PR (-1)

DLLRCPS1 = LLRCPS (-1)-LLRCPS (-2)

DANF1M1 = ANF1M(-1)-ANF1M(-2)

DLREER1 = LREER(-1)-LREER(-2)

DPR1 = PR (-1)-PR (-2)

DTMTDR1 = TMTDR (-1)-TMTDR (-2)

ECC: Error Correction Term

Extending the base VECM by the savings interest rate, the dynamic responses to a one-standard-error shock to the policy interest rate from the estimated VECM (2) model (see Appendix Table VI B) are shown in Figure 7.3.2A below. The impulse response indicates that the addition has no significant impact on the responses of the base variables. Regarding the added variable, its dynamic response corresponds well with that of the policy interest rate, in shape and significance, suggesting similar correspondence with the policy interest rate, when compared with that found from the bivariate model in Chapter 6. Figures 7.3.2B, C and D confirm the findings from the previous VECM specification and those from the single equation model of Chapter 5. This is that excluding the policy rate itself, interest rate responses to positive innovations in inflation, output gap, and the real exchange rate are insignificant, with the direction of interest rate response for output gap being negative in the short to medium term.

**Figure 7.3.2A**

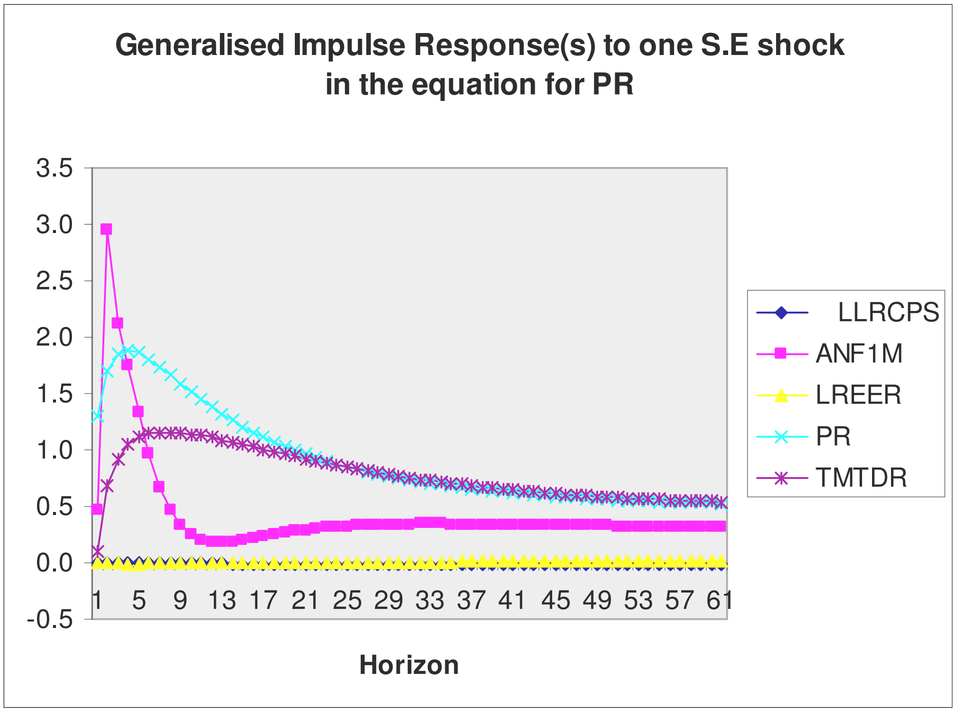



**Figure 7.3.2B**

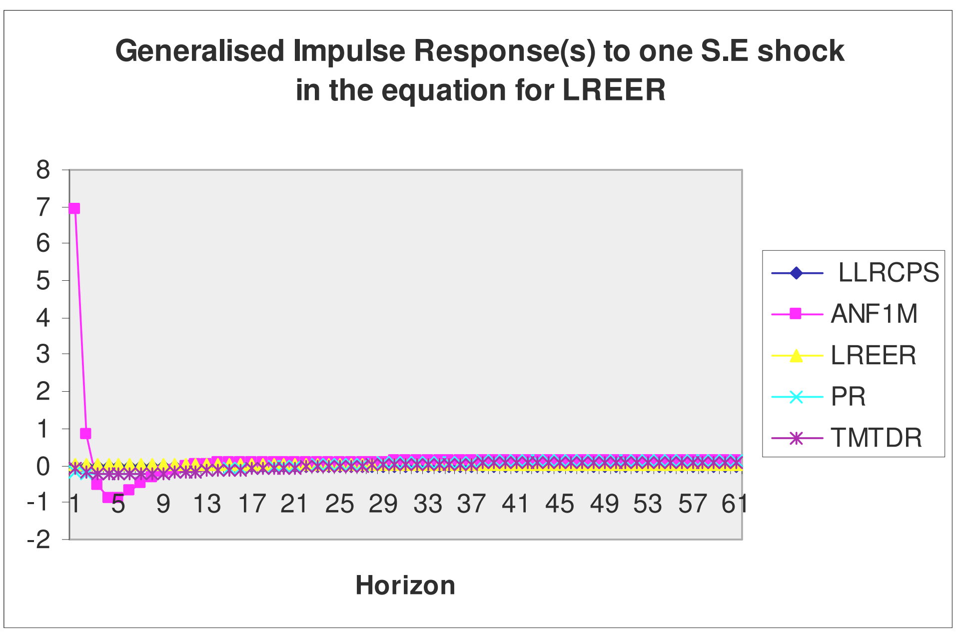


**Figure 7.3.2C**

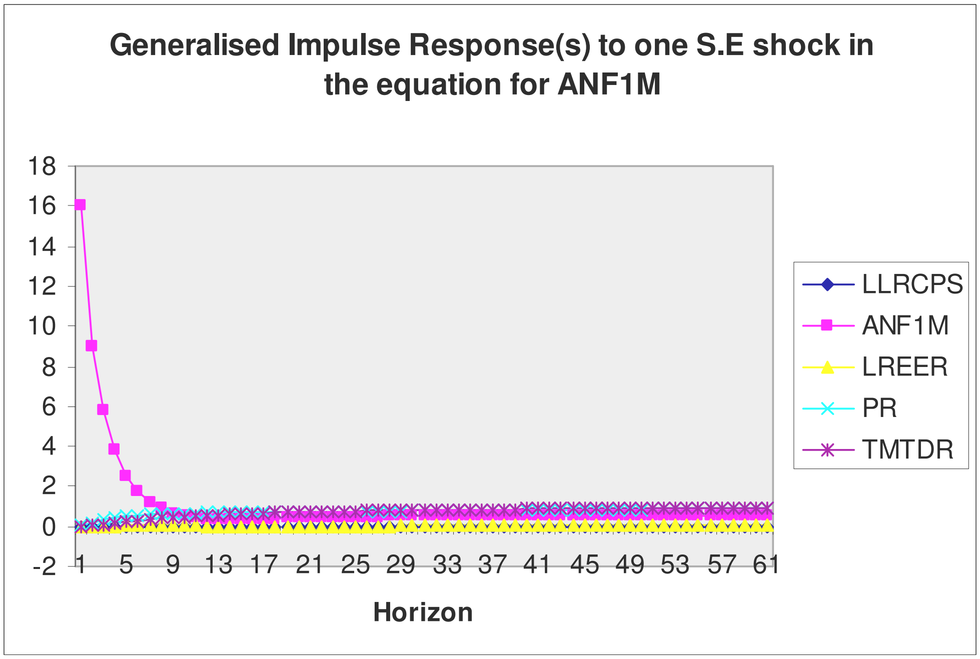



**Figure 7.3.2D**

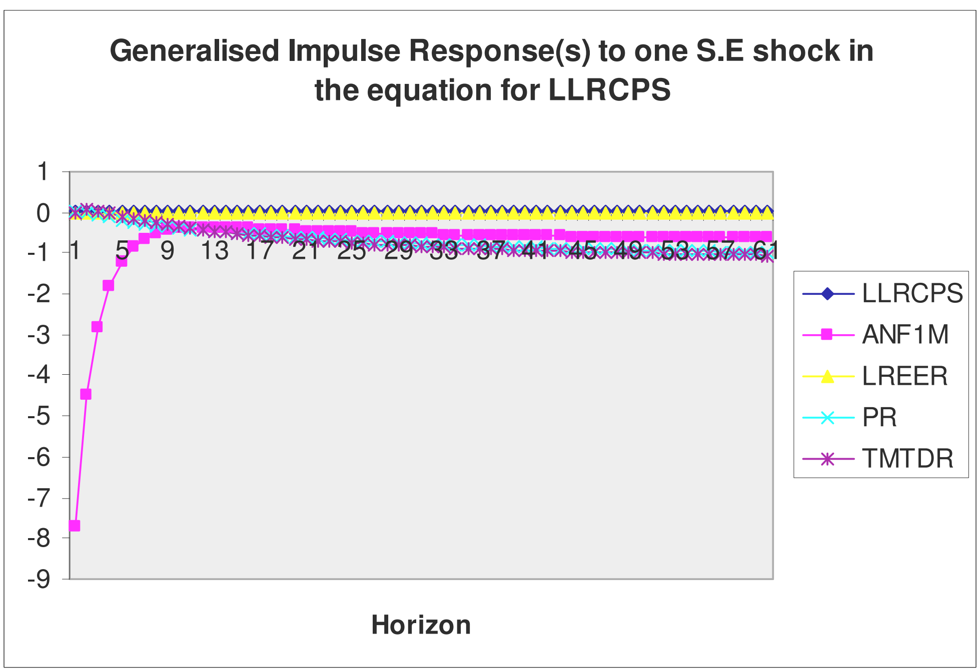
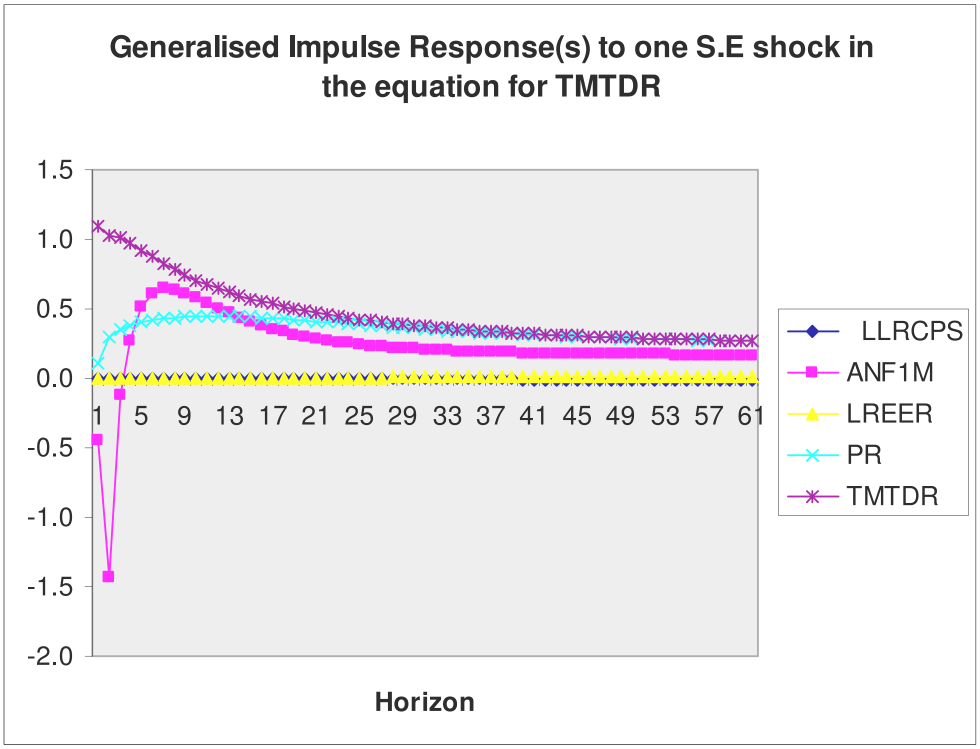


**Figure 7.3.2E**




### 7.3.3 Results from the Further Extended VECM

Extending the VECM further by real broad money (ANRMO21M) and starting with VAR (12), the AIC and SBC model selection criteria point to VAR(2) as the appropriate description of the data (see Appendix Table VI C). Specifying the cointegrating relationship without a time trend, both the trace and maximal eigen value tests suggest the existence of two cointegrating vectors at the 5 per cent level for the period 1992M1-2007M1. The test results are shown in Table 7.3.3A.

**Tables 7.3.3A**

**Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 2.

List of variables included in the cointegrating vector:

LLRCPS ANF1M LREER PR TMTDR ANRMO21M

List of eigenvalues in descending order:

0.46904 0.27438 0.074867 0.052797 0.018451 0.0027177

| Null | Alternative | Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r = 1 | 114.5849 | 36.2700 | 33.4800 |
| r<= 1 | r = 2 | 58.0531 | 29.9500 | 27.5700 |
| r<= 2 | r = 3 | 14.0851 | 23.9200 | 21.5800 |
| r<= 3 | r = 4 | 9.8177 | 17.6800 | 15.5700 |
| r<= 4 | r = 5 | 3.3708 | 11.0300 | 9.2800 |
| r<= 5 | r = 6 | 0.49258 | 4.1600 | 3.0400 |

**Cointegration LR Test Based on Trace of the Stochastic Matrix**

Sample from 1992M1 to 2007M1. Order of VAR = 2.

List of variables included in the cointegrating vector:

LLRCPS ANF1M LREER PR TMTDR ANRMO21M

List of eigenvalues in descending order:

0.46904 0.27438 0.074867 0.052797 0.018451 0.0027177

| Null | Alternative | Statistic | 95% Critical Value | 90% Critical Value |
|---|---|---|---|---|
| r = 0 | r>= 1 | 200.4041 | 83.1800 | 78.4700 |
| r<= 1 | r>= 2 | 85.8192 | 59.3300 | 55.4200 |
| r<= 2 | r>= 3 | 27.7661 | 39.8100 | 36.6900 |
| r<= 3 | r>= 4 | 13.6811 | 24.0500 | 21.4600 |
| r<= 4 | r>= 5 | 3.8633 | 12.3600 | 10.2500 |
| r<= 5 | r = 6 | 0.49258 | 4.1600 | 3.0400 |

Further extending equation 7.8 by broad money, the short-run dynamics of the long-run relationship can be described by an error-correction model as follows:

$$DPR = \beta_0 + \sum_{i=0}^{n} \beta_{1i} DLREER + \sum_{i=0}^{n} \beta_{2i} DANF1M + \sum_{i=0}^{n} \beta_{3i} DLLRCPS + \sum_{i=0}^{n} \beta_{4i} DTMTDR$$
$$+ \sum_{i=0}^{n} \beta_{5i} DANRMO21M + \sum_{i=1}^{n} \beta_{6i} DPR_{t-i} + \beta_7 ECC_{t-1} + \varepsilon_t \tag{7.9}$$

where *ECC* is the error correction component and n is set equal to 2, as the AIC and SBC model selection criteria point to VAR(2) as the appropriate description of the data. The results are shown below in Table 7.3.3B.

**Table 7.3.3B**

Error correction model for variable PR estimated by OLS based on cointegrating VAR (2). Dependent variable is Change in policy rate, DPR

Sample for estimation from 1992M2 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| DLLRCPS1 | 1.0701 | 1.7851 | 0.59945[0.550] |
| DANF1M1 | -0.0011525 | 0.0068832 | -0.16744[0.867] |
| DLREER1 | -2.1034 | 3.8942 | -0.54013[0.590] |
| DPR1 | 0.31904 | 0.074209 | 4.2992[0.000] |
| DTMTDR1 | 0.10083 | 0.078442 | 1.2854[0.200] |
| DANRMO21M1 | -0.0014024 | 0.0020785 | -0.67473[0.501] |
| **ECC(-1)** | **0.69201** | **1.3185** | **0.52482[0.600]** |
| **ECC(-1)** | **1.9739** | **1.3185** | **1.4970[0.136]** |
| R-Squared | 0.17618 | R-Bar-Squared | 0.14284 |
| S.E. of Regression | 1.3185 | F-stat. F( 7, 173) | 5.2852[0.000] |
| DW-statistic | 1.9874 | | |

| Diagnostic Tests | | |
|---|---|---|
| Test Statistics | LM Version | F Version |
| Serial Correlation | CHSQ( 12)= 9.0155[.702] | F( 12, 161)= 0.70331[0.747] |
| Functional Form | CHSQ( 1)= 1.2411[.265 ] | F( 1, 172)= 1.1875[0.277] |
| Normality | CHSQ( 2)= 217.3265[0.000] | Not applicable |
| Heteroscedasticity | CHSQ( 1)= 0.62582[0.429] | F( 1, 179)= 0.62105[0.432] |

Note:

DPR = PR-PR (-1)

DLLRCPS1 = LLRCPS (-1)-LLRCPS (-2)

DANF1M1 = ANF1M(-1)-ANF1M(-2)

DLREER1 = LREER(-1)-LREER(-2)

DPR1 = PR (-1)-PR (-2)

DTMTDR1 = TMTDR (-1)-TMTDR (-2)

DANRMO21M1 = ANRMO21M (-1)-ANRMO21M (-2)

ECC: Error Correction Term

Extending the VECM further by real broad money, the impulse response from a one standard error shock to the policy interest rate from an estimated VECM (2) model (see Appendix Table VI C) is shown in Figure 7.3.3A. Figures 7.3.3B, C and D indicate that the pattern of responses of the policy interest rate, savings interest rate, the real exchange rate, output gap, and inflation remains unchanged. The added variable, real broad money is significant to the policy tightening. In the short term, there is a significant decline in the first three (3) months. The responses of the policy interest rate to shocks to the variables also remain as previously discussed.

**Figure 7.3.3A**

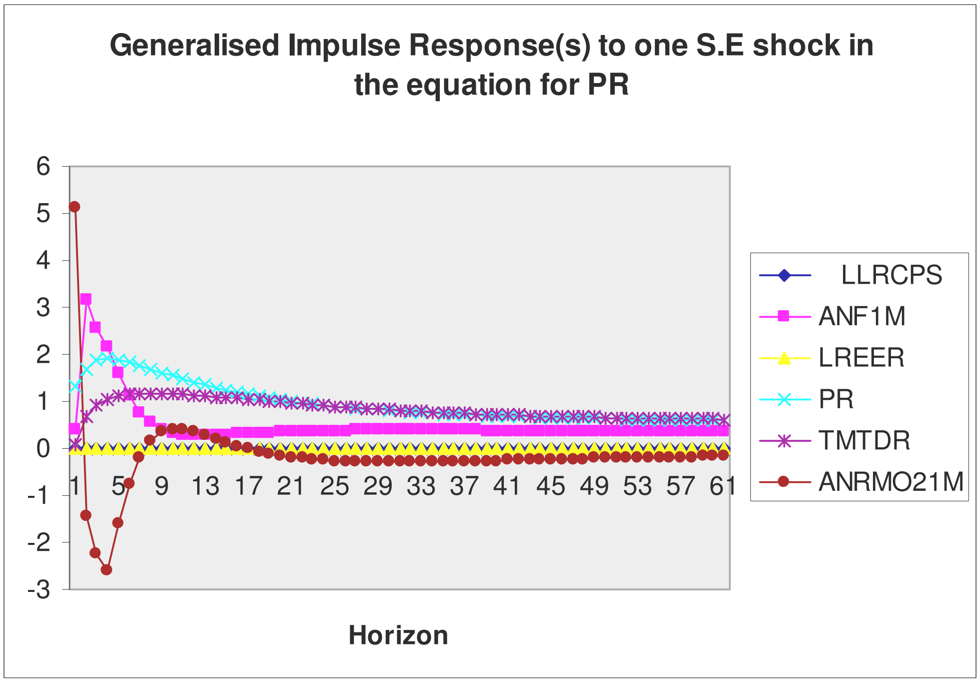



**Figure 7.3.3B**

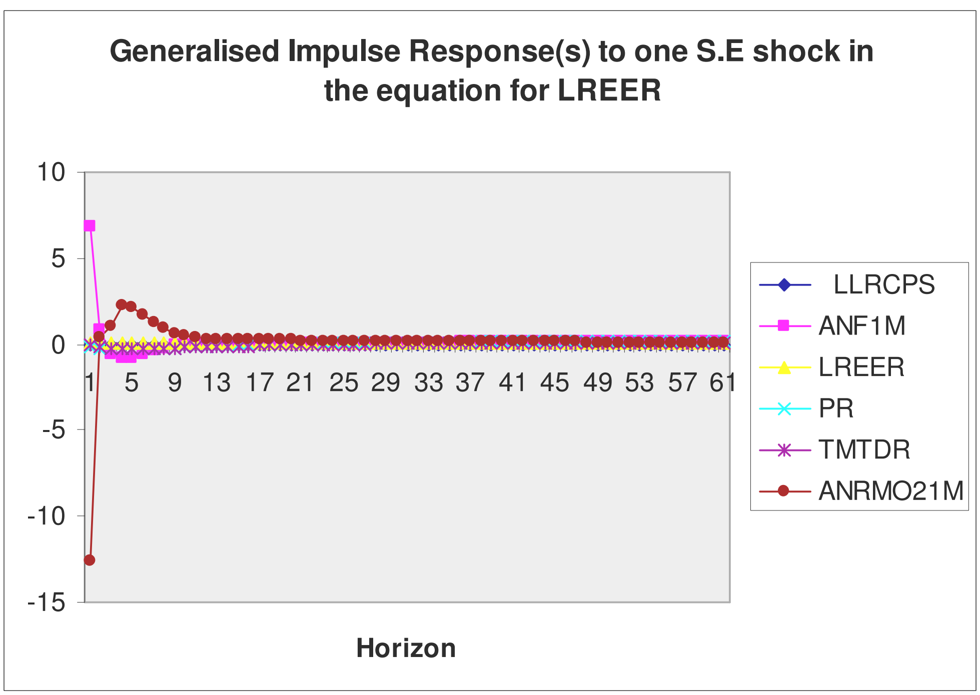


**Figure 7.3.3C**

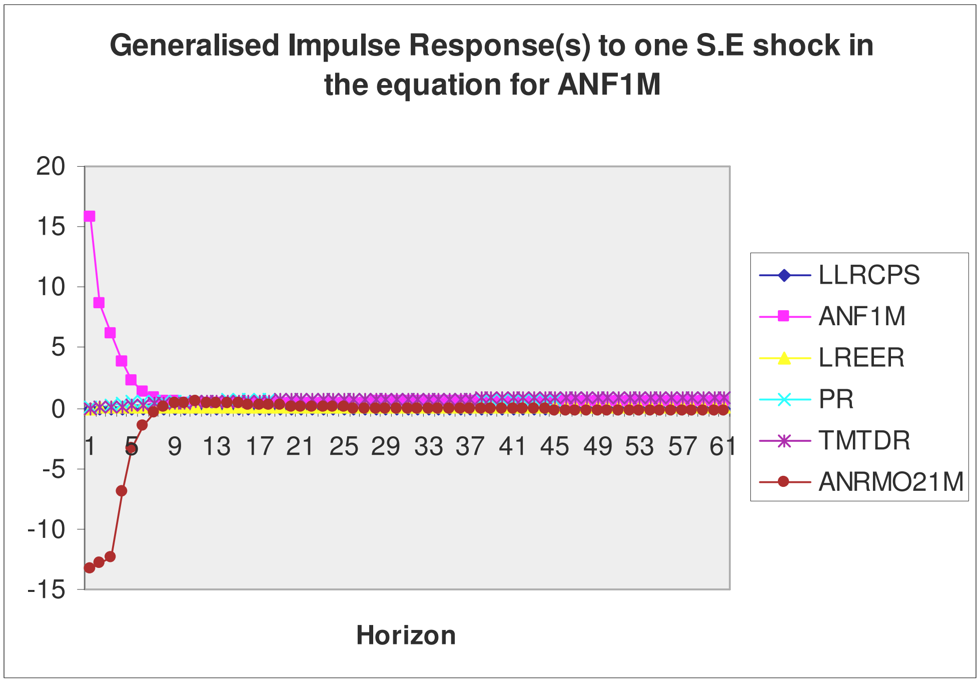



**Figure 7.3.3D**

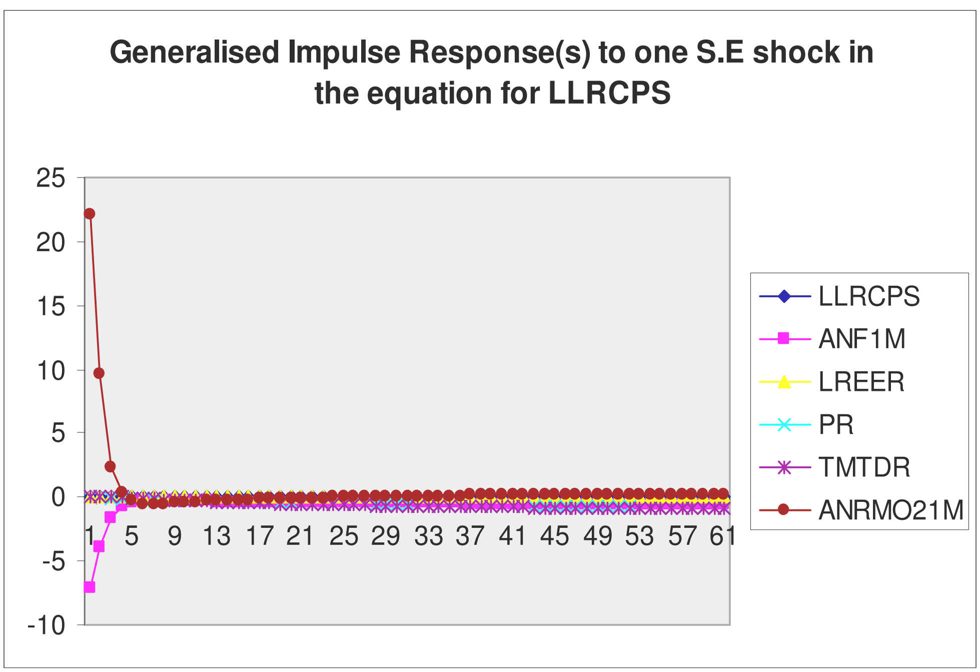


**Figure 7.3.3E**

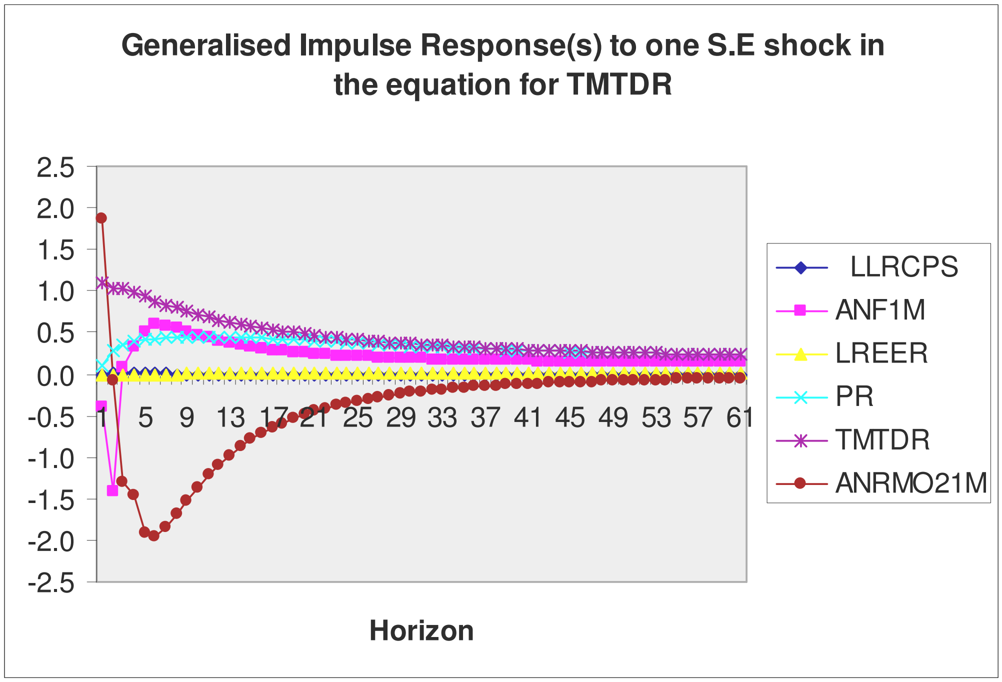
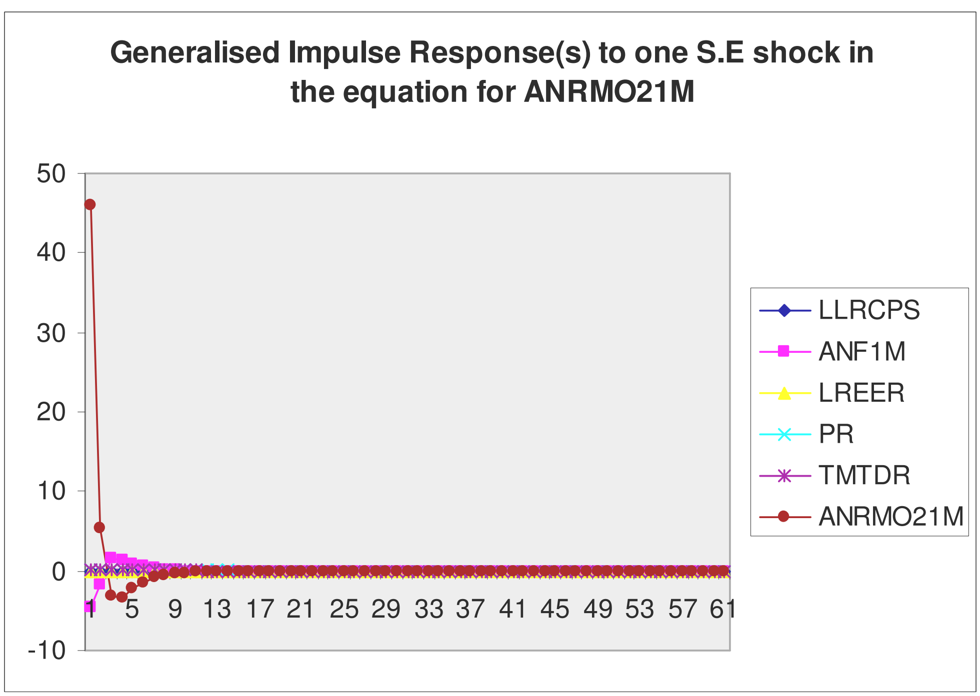



**Figure 7.3.3F**

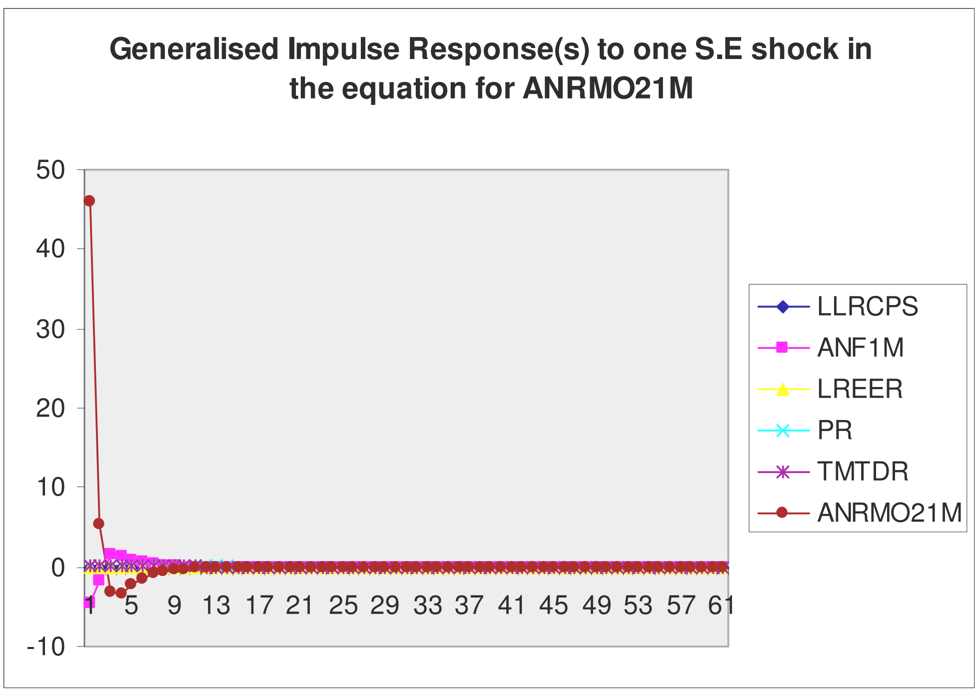


### 7.3.4 The Effects of Shocks

*The Effect of a Shock to Real Broad Money*

Figure 7.3.4A shows variables' response to a one-standard-error (45 percentage point) innovation in real broad money. None of the responses are significant, apart from the shocked variable's own response in the first eight months. Real broad money reverts to its baseline value fairly rapidly (by the 10th month). Distinctly, the policy rate remains unresponsive to the rise in real broad money. The savings interest rate response is similarly low and insignificant. Inflation rises but falls back to its base level by the eighth month.

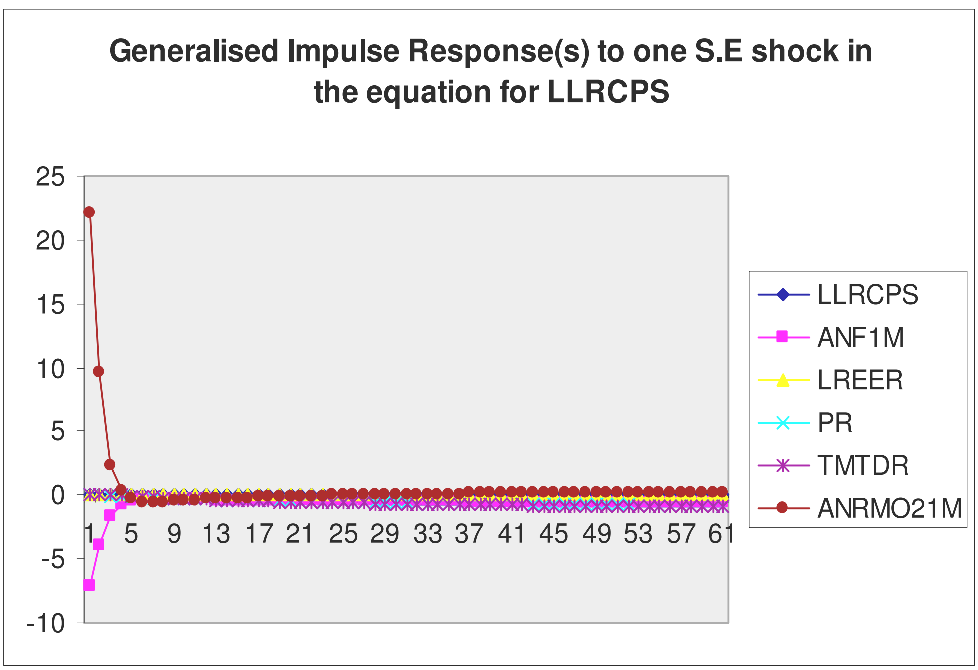
**Figure 7.3.4A**



*The Effect of a Shock to Output*

Figure 7.3.4B shows the effect of a positive shock on the output gap. With the exception of inflation and real broad money in the first seven (7) months, when inflation rises relative to the base and real broad money falls, variables' responses are insignificant. The patterns of responses of the interest rate variables (the policy rate and commercial bank savings rates) is insignificant. This policy rate response to output expansion agrees with the results from the single equation model of Chapter 5. The savings interest rate response mirrors that of the policy rate.

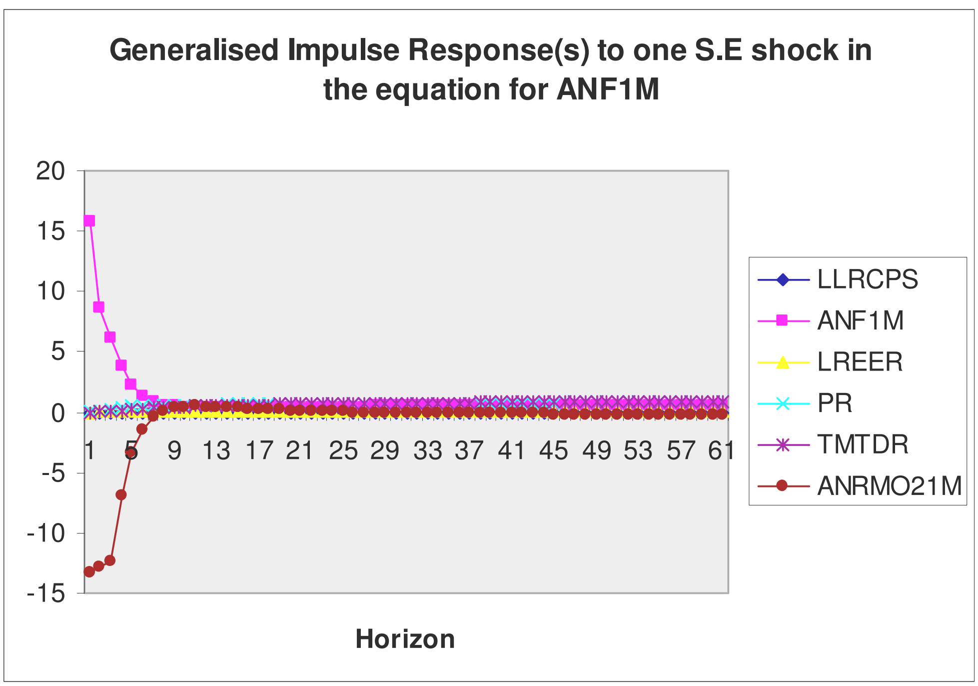
**Figure 7.3.4B**



*The Effects of a Shock to Inflation*

Figure 7.3.4C shows variables' impulse responses following an inflation shock. While inflation and real broad money responses in the initial months are significant, those of the interest rates, the output gap and real exchange rates are insignificant. Inflation, following the one-standard-error shock (equivalent to a 16 percentage point rise), returns rapidly to its base value, suggesting a fast process of mean reversion. The policy interest rate response is weak and insignificant, although there is a response after a three month lag, which corresponds with the finding from the single equation model in Chapter 5. The savings interest rate follows the pattern of policy rate response, showing the same level of insignificance. The exchange rate and output gap responses are also insignificant.

**Figure 7.3.4C**



### 7.4 Summary and Conclusion

Results show variables' impulse responses following an unanticipated monetary policy tightening are generally insignificant for output gap and real exchange rate, but show the following trends. The impulse indicates that while the policy interest rate responds throughout the horizon and inflation response in the initial fifteen months is significant, those of output gap and real exchange rate are insignificant. The policy interest rate response function shows that the variable follows a slow process of mean reversion following the shock. Inflation falls for about 15 months, and stabilises in the ensuing 45 months. Also, the savings interest rate shows similar co-movement with the policy rate, as found from the bivariate model of Chapter 6.

Following a positive shock to inflation, the policy interest rate rises, but weakly and insignificantly. Also, the policy interest rate does not show any significant response following a shock to output gap. These results correspond well with the findings in Chapter 5, where a weak response of the policy interest rate to inflation and a negative response to output gap were found.

Regarding the commercial bank savings interest rate, its dynamic response corresponds well with that of the policy interest rate, in shape and significance, suggesting similar correspondence of the policy interest rate with that found from the bivariate model in Chapter 6.

All together, the pattern of variables' dynamic responses to policy tightening, and the response of the policy instrument to key variables, indicate weak monetary policy effectiveness. The drawback of some insignificant dynamic responses notwithstanding, the inferred optimal timing of monetary policy is about 15 months ahead. It follows that an unanticipated monetary policy tightening effect on inflation, the final target of monetary policy, could take up to 15 months.

Chapter 8 provides a concluding summary of the results obtained in chapters 5, 6 and 7 and also presents policy recommendations for inflation control.

# Chapter 8

# Conclusion and Policy Recommendations

## 8.1 Introduction

The empirical literature on monetary policy is currently skewed to industrialised countries, despite the convergence in the aims and objectives of monetary policy and in the methods for its conduct worldwide. To broaden the field of the literature, provide country-specific assessment of monetary policy, and generally contribute to the policy advice on inflation control, this thesis has extended the literature to Ghana. The literature on the financial sector and monetary management in SSA have tended to rank South Africa, Kenya, and Ghana amongst the best performing countries in the region, with South Africa and Kenya found to have the most developed financial sectors and systems of monetary management. Thus, the financial sector and system of monetary management in Ghana is more representative of SSA hence, its study may serve a broader purpose in providing a general understanding of the monetary policy transmission mechanism in SSA.

Monetary policy in Ghana has changed considerably since the launch of the Economic Recovery Programme (ERP) in 1983, in line with changes in the financial system. Whilst the objective aspect of monetary policy – price stability – has remained basically unchanged, there have been substantial changes elsewhere, especially with regard to the instruments used. The instruments of monetary policy have been improved and more indirect and market based instruments have been developed.

This final chapter thus aims to present a concluding summary of the results, provide policy recommendation towards the attainment of the overriding objective of monetary policy-inflation control, and offer some suggestions for future work.

The chapter is structured as follows. Brief summaries of findings from the empirical analysis are presented in Section 8.2 and 8.3. The policy recommendations then follow in Section 8.4. Section 8.5 provides some suggestions on areas for future work, while Section 8.6 then ends the chapter.

## 8.2 Monetary Policy Conduct

The monetary policy setting in Ghana is typical of a small open developing economy. In an open economy, the conventional wisdom is that standard channels for the transmission of monetary policy actions are through aggregate demand, expectations which affect inflation via price setting behaviour, the exchange rate, via the interest parity conditions dependent on the difference between domestic and foreign interest rates, and expected future changes in exchange rates. All these work in a complex interaction through the system into the price level.

Estimating monetary policy conduct over the sample period (1992M1-2007M1) has involved investigating the consistency of three hypotheses for policy conduct with the data, by estimating Taylor-type reactions functions for Ghana to uncover the best empirical characterisation of monetary policy formation in the country. First, the central bank set interest rates in response solely to inflation, known as inflation targeting. Second, the central bank responded only to inflation and output in accordance with Taylor's rule. Third, the central bank responded to a broader information set. The first two hypotheses were found inconsistent with the data, but the third was consistent.

The finding on the first hypothesis concludes that an assumption of inflation targeting in the strict sense is not an appropriate description of Ghana's monetary policy between 1992M1-2007M1 given a low inflation coefficient and evidence of model misspecification.

With an incorrectly-signed policy interest rate response to output gap and a minute policy interest rate response to inflation, the finding on the second hypothesis suggests an absence of central bank commitment to price stability over the 1992M1-2007M1.

The equation that best described monetary policy conduct was presented and discussed to answer the question on how the central bank conducted monetary policy since it adopted market-based instruments in 1992. This equation, a generalised specification, shows the significance of foreign monetary policy and international market volatility to monetary policy conduct in Ghana.

## 8.3 Monetary Policy Effectiveness

Evaluating monetary policy effectiveness[47] involved the use of three approaches. First, the sizes of the long-run interest rate responses to inflation and output gap deduced from the estimated Taylor-type reaction functions were compared with the theoretical specifications of at least unity for inflation and about 0.5 for output gap. This also involved determining if interest rate responses to the other precursors of inflation were correctly-signed, significant, and appropriately sized.

The results showed that monetary policy was not effective in stabilising inflation, based on the low inflation coefficient and evidence of model misspecification. A one per cent increase in inflation raised the policy interest rate by 0.74 percentage point between 2002M4 and 2007M1, which is higher than the 0.18 percentage point witnessed between 1992 M1 and 2002 M3. The high inflation coefficient may reflect the fact that Ghana's central bank established an implicit inflation targeting framework in 2002. However, the value is still lower than the reference value proposed by Taylor (1993).

When output is added to the inflation model the coefficients suggest that (i) holding the effect of output gap constant, a one percentage point rise in inflation leads to a 0.35 percentage point rise in the policy interest rate; and (ii) holding the effect of inflation constant, a one percent rise in output above trend leads to a 0.18 percentage point reduction in the policy interest rate.

The incorrectly-signed interest rate response to output gap suggests that the central bank's monetary policy conduct over the period accommodated aggregate demand

[47] Monetary policy effectiveness as used is the strength of policy interest rate response to inflation and other information variables for policy conduct; as well as the extent to which the policy interest rate influences market interest rates and macroeconomic aggregates.

pressures. Possible reasons include the central bank's actual objective being one of boosting output and employment rather than maintaining price stability; and with a belief in the Phillips Curve relationship, it may deliberately have aimed to accommodate some level of inflation to achieve this objective - a typical dynamic inconsistency problem. Another plausible explanation is that, while mindful of the need to respond appropriately to aggregate demand pressures, the central bank was unable to because of the budgetary implications of rises in the Treasury bill rate, given that sizeable issues of Treasury bills are to fund the government budget. As such, large issues over and above government budgetary needs further exacerbate the fiscal burden, necessitating an accommodative monetary policy stance.

Other precursors of inflation expected to be important to the BOG are foreign exchange reserves, exchange rate, foreign interest rates and international market volatility as the central bank is charged with the management of the country's foreign exchange reserves and with the protection of the external value of the local currency. The estimations found foreign exchange reserves consistently correctly (negatively) signed and significant; however, the real effective exchange rate is insignificant, suggesting that the central bank raised the policy rate with cuts in foreign exchange reserves and vice versa, which is its foreign exchange reserves management mandate. Independently, this also suggests an absence of focus on the exchange rate, at least in real effective terms.

The significance of the US federal funds rate and US dollar price of oil suggests that the BOG conducts monetary policy taking cognisance of foreign monetary policy and international market volatility.

A finding of a full pass-through was interpreted as signifying effectiveness in the transmission of monetary policy impulses to the retail savings rate in the second approach - an important pre-requisite if policy impulses are to influence the real economy. With this approach evaluating policy effectiveness involved investigating the responsiveness of commercial bank savings rates to changes in the policy interest rate. This was done by testing for the existence of a relationship in levels between the two interest rates. The long-run pass-through, monthly disequilibrium correction, as well as the short-run pass-through were computed. High short-run pass-through and sizeable monthly disequilibrium correction, we deemed, enhanced policy effectiveness.

Both the single equation error correction approach and the pass-through process, estimated within a VECM framework for the savings interest rate and the policy interest rate, indicate a fairly rapid adjustment of the savings interest rate towards its equilibrium value.

The long-run pass-through process shows high responsiveness over the sample period. A pass-through value of 0.90 suggests that the policy interest rate is positively correlated with the commercial bank savings rate, and about 90 per cent of the shock to the policy interest rate is passed-through to the savings rate in the long run. However, this value is lower than unity, which is the reference value in the empirical literature. The results also show that the contemporaneous effect of a percentage point rise in the policy interest rate is a rise in the savings rate of 0.38, increasing by a further 0.16 after the second month.

Assessing the effectiveness of monetary policy on the basis of the strength of responsiveness of commercial bank retail rates, particularly the saving rate to policy interest rates, the research concludes that with a near unity pass-through rate in the long-run, monetary policy was largely effective[48] in influencing the savings rate in Ghana over the period 1992M1-2007M1.

The third approach to monetary policy effectiveness evaluation was to investigate monetary policy transmission more fully. Policy effectiveness was determined by the pattern of variables' responses to monetary policy shocks.

Variables' impulse responses following an unanticipated monetary policy tightening are generally insignificant for output gap and real exchange rate, but show the following trends. The impulse indicates that while the policy interest rate responds throughout the horizon and inflation response in the initial 15 months is significant, those of output gap and real exchange rate are insignificant. The policy interest rate

[48]Less than full pass-through was interpreted as signifying that the transmission of monetary policy is largely effective.

response function shows that the variable follows a slow process of mean reversion following the shock. Inflation falls for about 15 months, and stabilises in the ensuing 45 months.

Following a positive shock to inflation, the policy interest rate rises, but weakly and insignificantly. Also, the policy interest rate does not show any significant response following a shock to output gap. The dynamic response of commercial bank savings rate corresponds well with that of the policy interest rate, in shape and significance. Again, from the analysis, monetary policy was found to be largely effective in influencing saving rate but was not effective in stabilising inflation.

## 8.4 Policy Recommendations

Based on the empirical analysis in Chapters 5 and 6, the results of Chapter 7 and an appeal to the broader literature, we present policy recommendations for sustainable inflation control in the section.

Even as the general empirical evidence on the relationship between central bank independence and inflation is mixed (see Chapters 3 and 4), the government accounts for a substantial portion of the country's financial liability in Ghana. The attainment of the price stability objective may thus be facilitated by an environment of effective central bank independence. Although the central bank has been operationally independent since 2002 the need for effective independence is underscored, as provisions to guarantee some level of central bank independence have been in place since 1992.

The incorrectly-signed interest rate response to output gap suggests that the central bank's monetary policy conduct over the period accommodated aggregate demand pressures. A plausible explanation is that, while mindful of the need to respond appropriately to aggregate demand pressures, the central bank was unable to because of the budgetary implications of rises in the Treasury bill rate, given that sizeable issues of Treasury bills are to fund the government budget. As such, large issues over and above government budgetary needs further exacerbate the fiscal burden, necessitating an accommodative monetary policy stance. This suggests that the central bank lacked the independence required to control inflation.

This thesis therefore recommends the enhancement of provisions for independence, transparency and accountability of the central bank. Following Khan (2003), transparency is used in the following context. First, is the existence of an explicit inflation target. Second, is the availability of clear and sufficient information to the public for the assessment of the monetary policy stance. Third, in the event of changes in monetary policy, a clear explanation of the reasons behind the changes, and the expected impact on inflation outlook, should be provided. Fourth, an ante indication of possible target breach, its causes and the policy actions to be taken to bring inflation back on track should be provided. Finally, there should be an ex-post comprehensive analysis of the performance of monetary policy.

We commend Ghana for adopting an explicit inflation targeting framework in May 2007. Inflation targeting embraces the advantages of transparency and accountability outlined. It further compels policy makers to deepen reforms, provide an operational rule for the conduct of monetary policy, improve financial stability and eventually converge to international level inflation. It also helps clarify the responsibilities of the central bank and other executive branches of government.

We acknowledge that inflation targeting is not a panacea and that its success is dependent on the existence of a stable macroeconomic framework and the elimination of debilitating structural bottlenecks.

To facilitate transparency and accountability, the thesis recommends that the central bank publicly declare the benchmark rule that it follows for policy conduct[49]. In line with the advice in the literature (e.g. Taylor 1993, 1999a and McCallum 2000), the recommendation for a guideline rule is not to suggest that it be followed mechanically, but rather be used only as a guide. This would have the added benefit of stabilising inflationary expectations and even breaking inflation psychology. Examples of emerging market economies that have used inflation targeting to build credibility, bring down inflation expectations, and pursued a path of convergence to

[49] An example of such a guideline rule is the inflation targeting already being implemented in South Africa.

low and stationary inflation are Chile and Israel (Mishkin and Schmidt-Hebbel, 2001).

Regarding the conduct of monetary policy, results showed that monetary policy was not effective in stabilising inflation based on the low inflation coefficient and evidence of model misspecification. Possible reasons may include the central bank's inability to control excess liquidity in the economy and the small and narrow size of the market for government securities.

Ghatak and Sánchez-Fung, (2007) outline some of the reasons for monetary policy ineffectiveness as: (i) excess liquidity in the economy that nullifies the effect of a rise in the policy interest rate, (ii) the narrow size of the bill market, (iii) absence of a sufficiently large, active, and diversified market for government securities and a developed call-loan market that allows commercial banks to maintain low and stable cash-deposit ratios, such that central bank open market operations will have an immediate effect on them, and (iv) large non-monetised sectors of the economy.

Ghana, where excess reserves of commercial banks are relatively high, diversified markets for government securities are absent, and with weak interbank markets, provide support for the arguments of Ghatak and Sánchez-Fung, (2007). Under these conditions, a policy rate move aimed at signalling tight monetary policy may not necessarily lead to the desired rise in market interest rates or the desired reduction in credit.

This thesis suggests that the effectiveness of monetary policy would be enhanced if the country took measures to: (i) remove the excess liquidity in the economy; (ii) develop a call-loan market that would allow commercial banks to maintain low and stable cash-deposit ratios; and (iii) de-emphasise the dependence on primary issues of bills for money market interventions in favour of secondary market instruments, such as repurchase agreements. Furthermore, it may be prudent for inflation control to be facilitated in the interim by other policy tools such as fiscal policy.

Results suggest an absence of focus on the exchange rate, which has led to an unstable exchange rate. The country has a high degree of openness, so an unstable exchange rate makes inflation control quite difficult. We recommend exchange rate targeting policies to control its volatility.

Foreign exchange constraints arising largely from imbalance in import and exports or exogenous terms of trade are likely to fuel inflation. On some empirical evidence, Loungani and Swagel (2001) find that the most important source of inflation in developing countries is the inertial component of inflation, which they interpret to mean structural factors including a trade imbalance. The estimations of Kapur *et al.* (1991), of determinants of inflation in Ghana, also found structural variables - food supply and supply costs - to be highly significant.

As such, while monetary policy remains centre stage in inflation control, and supported by prudent fiscal policy, the thesis also recommends the adoption of measures to eliminate structural impediments to production; and to aim for a balance in its trade with the rest of the world.

## 8.5 Limitations and Areas of Future Research

The choice of a policy instrument is a limitation in this study. Taylor (2000) contends that for developing countries, there may be a need to consider policy rules with a monetary aggregate as an instrument, rather than the interest rate employed in the Taylor rule. His reasoning, following Poole (1970), is that even though the use of a monetary aggregate or an interest rate as a policy instrument is equivalent, the choice between the two may be dictated by the composition of shocks the economy faces. An alternative model (Appendix XA and XB) that uses monetary aggregates as a policy instrument appears to explain monetary policy better. Future study may compare the two models in greater detail to determine which model better explains monetary policy in Ghana.

This thesis has proposed a more suitable monetary policy rule for developing countries in Chapter 4. Future research may apply this proposed rule to a broad sample of developing and emerging country data to establish its robustness. This will enable modifications, if necessary, so it usefully serves as a benchmark rule for developing countries.

Also, in the monetary transmission mechanism analysis, future work should disaggregate output into its key components to investigate the components most responsive to monetary policy impulses. Given the sizeable informal sector in the country, future research should also look into the design of optimal monetary policy in the presence of such sizeable informal sectors.

Furthermore, the analysis of the monetary transmissions mechanism can further investigate the credit channel of monetary policy. In particular, the role of credit market imperfections and the relative importance of alternative sources of credit (e.g. trade credit) in the monetary transmission mechanism should be evaluated.

The analysis of the responsiveness of market interest rates to changes in the policy interest rate proxied market interest rate by commercial bank savings rate. Future research should extend this to the commercial bank lending rate and to long-term interest rates.

Finally, the thesis considers it undesirable to employ estimation methods that are based on the assumption that the variables have a particular order of integration in view of the acknowledged low power of stationarity tests, particularly in small samples. For this reason, we adopt the conditional equilibrium correction model (ECM) developed by Pesaran, Shin and Smith (2001) that is robust to the stationarity properties of the data. However, this model is only as good as the assumptions underlying it. A more comparative analysis in Chapter 5 could test the robustness of this method.

## 8.6 Conclusion

This thesis aimed to estimate empirically monetary policy conduct and investigate policy effectiveness in Ghana. Following the theoretical and empirical literature, it did so within the framework of monetary policy rules and the transmission mechanism of monetary policy. Following estimations of extended Taylor type rules, using a technique that is robust to the stationarity conditions of the data, the best characterisation of monetary policy was obtained. The subsequent analysis of policy effectiveness involved comparing the strength of interest rate responses to variables with the dictates of literature. The results showed monetary policy was not effective.

The first of the two other approaches used to analyse policy effectiveness involved estimating the responsiveness of the commercial bank savings rate to changes in the policy interest rate; and the second involved estimating the responsiveness of broader target and goal variables to monetary policy impulses. Again, the analysis showed that monetary policy was only somewhat effective in Ghana.

Seeking reasons for the ineffectiveness of monetary policy, we concluded that these could be attributed to the central bank institutional framework, the monetary policy framework, the depth of financial market, and the macroeconomic environment in the country.

From our findings and appealing to broader literature, the thesis has proposed policy measures that could improve the effectiveness of monetary policy and facilitate inflation control on a sustained basis. Policy measures proposed include central bank legal provisions that give it the independence required to control inflation, the deepening of the financial market and to improve monetary management generally, including exchange rate targeting polices to reduce its volatility and improved communication with citizens to influence inflation expectations. Finally the thesis also recommends the adoption of measures to eliminate structural impediments to production; and aim for a balance in its trade with the rest of the world. The thesis provided some suggestions for future research areas to explore the robustness of these initial findings and their applicability to other developing and emerging economies.

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# Appendix

***Formal Unit Root test***

Testing for unit roots in autoregressive time series models continues to receive considerable attention in the econometrics literature. The formal approaches employed for testing for stationarity are the Dickey Fuller (DF) and the augmented Dickey Fuller (ADF) tests and the Ng-Perron tests. The Dickey Fuller (DF) and the augmented Dickey Fuller (ADF) involves running the regression

$$\Delta Y_t = \alpha_0 + \alpha_1 T + \alpha_2 Y_{t-1} + \sum_{i=1}^{m} \beta_i \Delta Y_{t-i} + \varepsilon_t \qquad (5.12)$$

Where $Y_t$ is the variable of interest and $Y_{t-1}$ is the period lag of the variable. The choice of *m* depends largely on the number of available observations and is selected large enough to render the residual $\varepsilon_t$ white noise. Model selection criteria such as the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Hannan – Quinn Criterion (HQC) are then used to assess the appropriate number of lags required.

Different coefficient combinations imply the order of integration of the series $Y_t$ :

If $\alpha_1 = \alpha_2 = 0$ $Y_t$ is a difference-stationary process {integrated of order one (i.e. $Y_t \sim I(1)$ } and is thus non-stationary. Since differencing induces stationarity then the first difference of $Y_t$ is stationary.

If $\alpha_1 \neq 0, \alpha_2 < 0$ $Y_t$ is stationary. However, in this case $Y_t$ is a trend-stationary process implying that a deterministic trend must be removed to induce stationarity. That is, $Y_t$ is stationary about a linear trend.

If $\alpha_1 = 0, \alpha_2 < 0$ $Y_t$ is itself stationary {$Y_t \sim I(0)$ } and no trend, whether deterministic or stochastic, is present.

The *t* ratio of $\alpha_1$ is compared with the critical value of the $\tau_{\beta\tau}$ statistic and that of $\alpha_2$ against the values tabulated for the $\tau_\tau$ statistic. The latter, the *t* ratio on $\alpha_2$, is called the ADF test statistic. Both tests are conducted under the null hypothesis that the coefficient is zero, so that large '*t* ratios' suggest rejection of null (Dickey and Fuller, 1981).

Ng and Perron (2001) construct four test statistics that are modified forms of Philips and Perron (1988) $Z_{\alpha}$ and $Z_t$ statistics, the Bhargava (1986) $R_1$ statistic, and the Elliot et al. (1996) Point Optimal statistic. Ng and Perron (2001) argue that traditional unit root tests may suffer from two main problems. First, they may suffer from power problems when the autoregressive parameter is close to 1 and, second, when the errors of a Moving Average process are close to -1, it is necessary to have a high lag length in order to avoid size problems. However, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) tend to select a low order of the lag length. In order to overcome these issues, the authors propose a Modified Information Criterion (MIC) that controls for sample size. Additionally Ng and Perron (2001) propose a method to avoid the power problems associated to traditional unit tests. They proposed four tests:

$$\text{MZ}\alpha = (T^{-1} y_T^2 - s_{AR}^2)(2T^{-2}\sum_{t=1}^{T} y_{t-1}^2)^{-1}, \tag{5.13}$$

$$\text{MSB} = (T^{-2}\sum_{t=1}^{T} y_{t-1}^2 / s_{AR}^2)^{1/2}, \tag{5.14}$$

$$\text{MZ}_t = \text{MZ}\alpha * \text{MSB} \tag{5.15}$$

$$p\text{=0:}\quad \text{MP}_T = [c^{-2} T^{-2}\sum_{t=1}^{T} \tilde{y}_{t-1}^2 - \bar{c} T^{-1} \tilde{y}_T^2] / s_{AR}^2 \tag{5.16}$$

$$p\text{=1:}\quad \text{MP}_T = [c^{-2} T^{-2}\sum_{t=1}^{T} \tilde{y}_{t-1}^2 + (1-\bar{c}) T^{-1} \tilde{y}_T^2] / s_{AR}^2 \tag{5.17}$$

$\bar{c} = -7$ if $p$=0

$\bar{c} = -13.5$ if $p$=1

The tests for $p$=0 and 1 can be obtained upon replacing $y_{t-1}$ and $y_T$ by the residuals obtained from least squares detrending. All the tests are based on $s^2_{AR}$ , an autoregressive estimate of the spectral density at frequency zero of $\upsilon_t$. Let

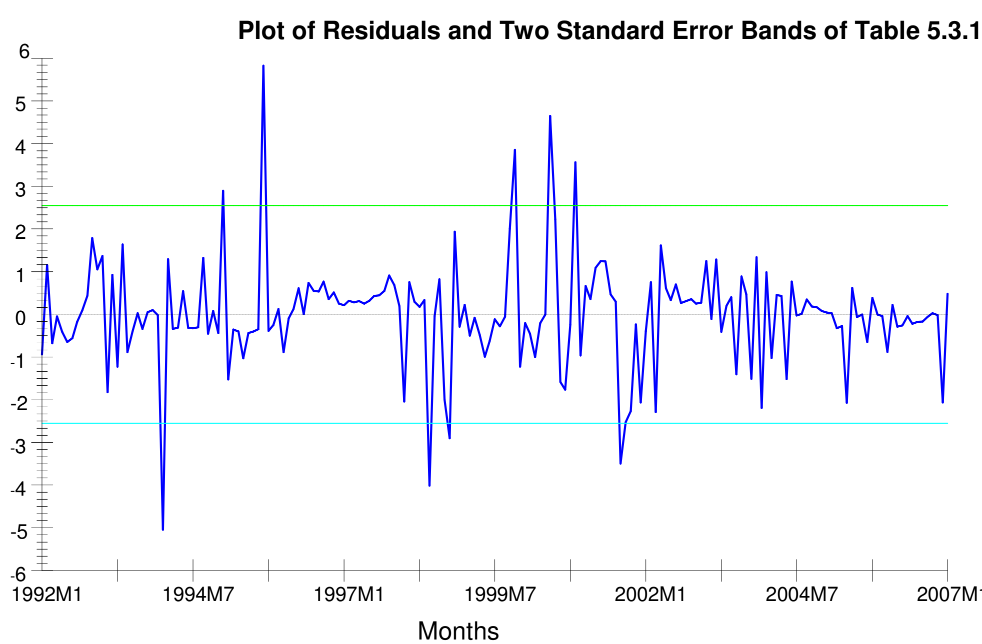
$\hat{\beta}(1) = \sum_{i=1}^{k} \hat{\beta}_i, \hat{\delta}^2_k$ with $\hat{\beta}_i$ obtained from equation (5.13) and $\upsilon_t = \delta$ (L) $\varepsilon_t$ .Then

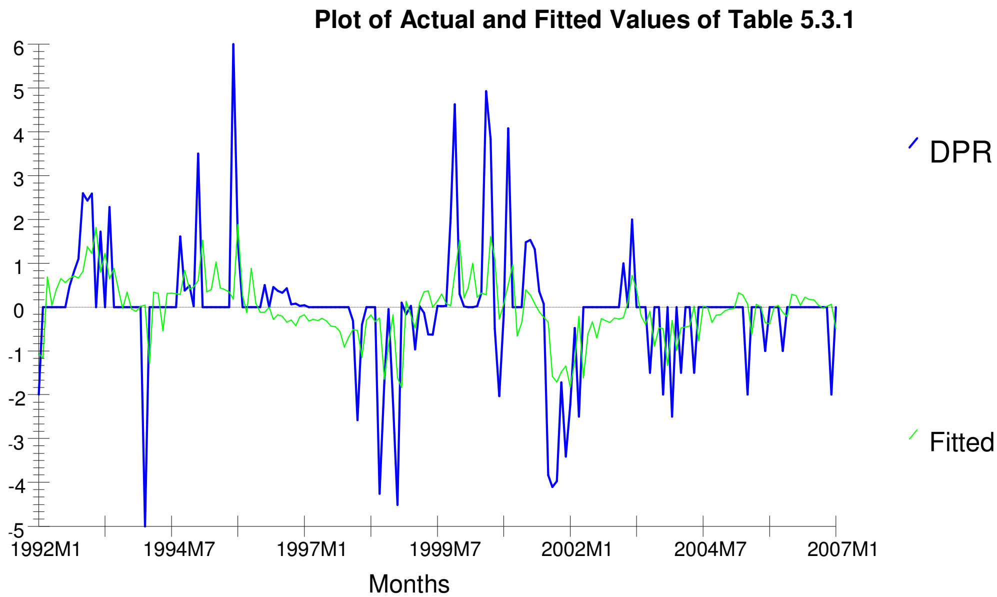
$$s^2_{AR} = \hat{\delta}^2_k / (1 - \hat{\beta}(1))^2. \qquad (5.18)$$

Null hypothesis ($H_0$): Variable has unit roots (*Ng-Perron Statistic* > *Ng-Perron Critical* ) . $s^2_{AR}$ converges to $\sigma^2$ under the null hypothesis of a unit root.

Alternative hypothesis ($H_0$): Variable is stationary (*Ng-Perron Statistic* < *Ng-Perron Critical* ). $T s^2_{AR}$ diverges under the alternative of stationarity.

**Some Plots of Chapter 5**




Plot of Actual and Fitted Values of Table 5.3.1
6
5
4
3
2
1
0
-1
-2
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1992M1
1994M7
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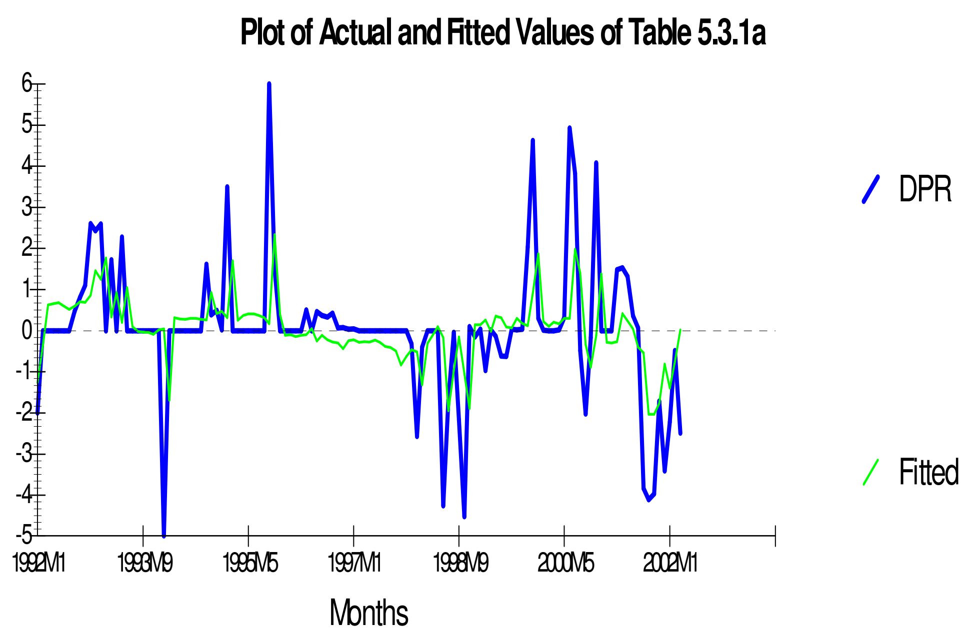
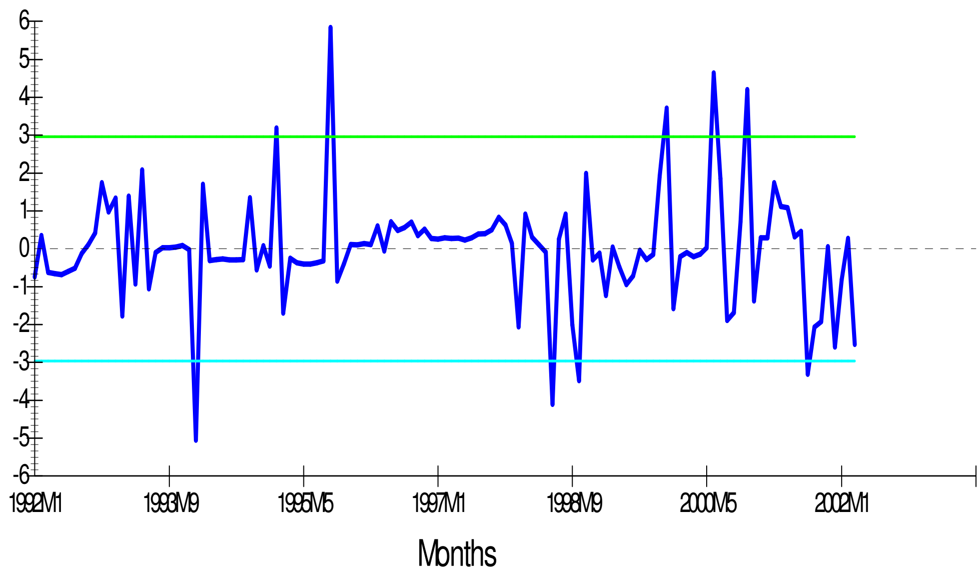
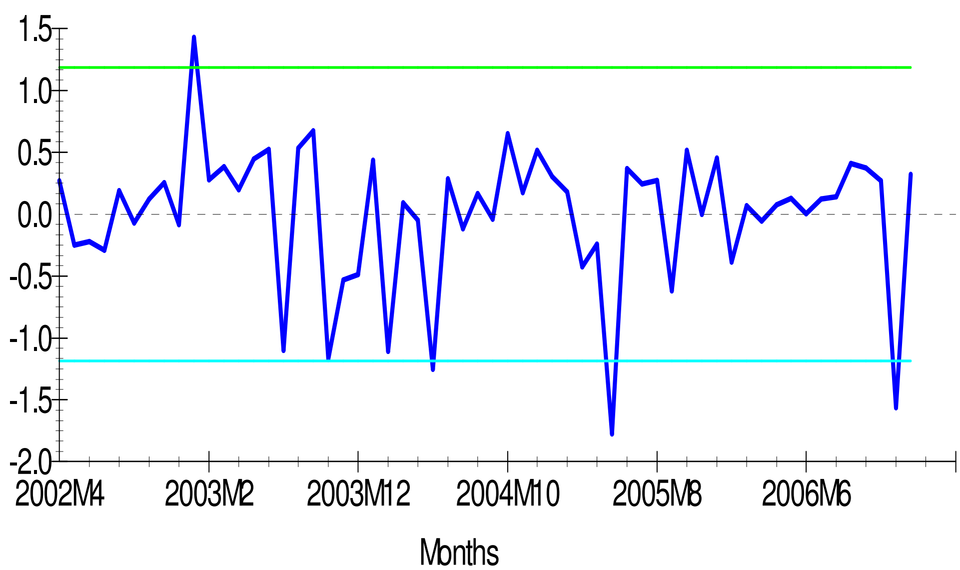
1999M7
2002M1
2004M7
2007M1
Months
DPR
Fitted


Plot of Actual and Fitted Values of Table 5.3.1a
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
1992M1
1993M9
1995M5
1997M1
1998M9
2000M5
2002M1
Months
DPR
Fitted

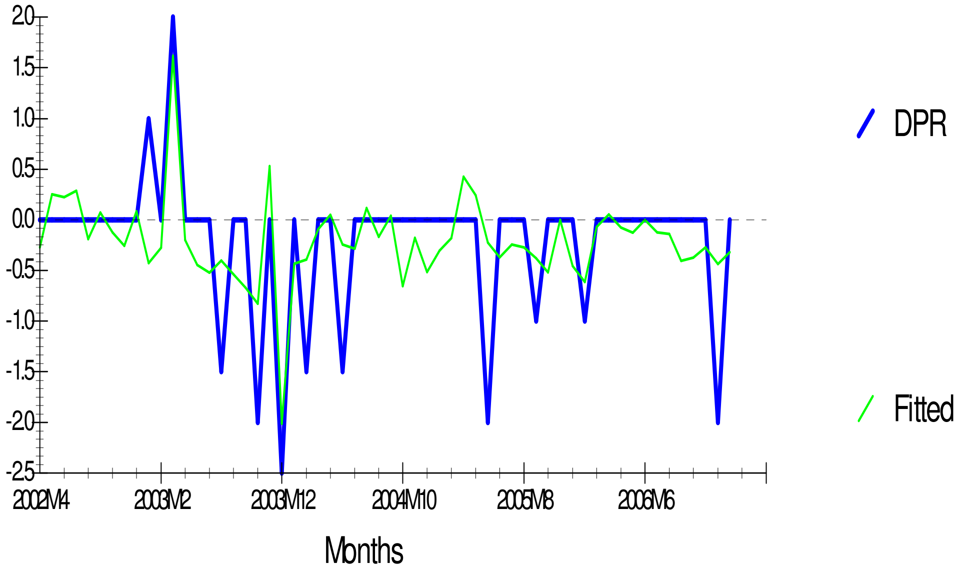
**Plot of Residuals and Two Standard Error Bands of Table 5.3.1a**



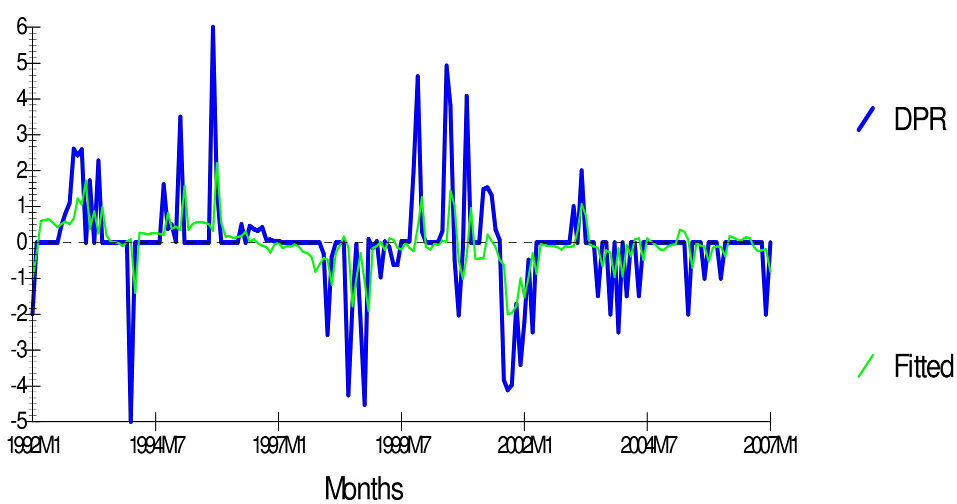

**Plot of Residuals and Two Standard Error Bands of Table 5.3.1b**



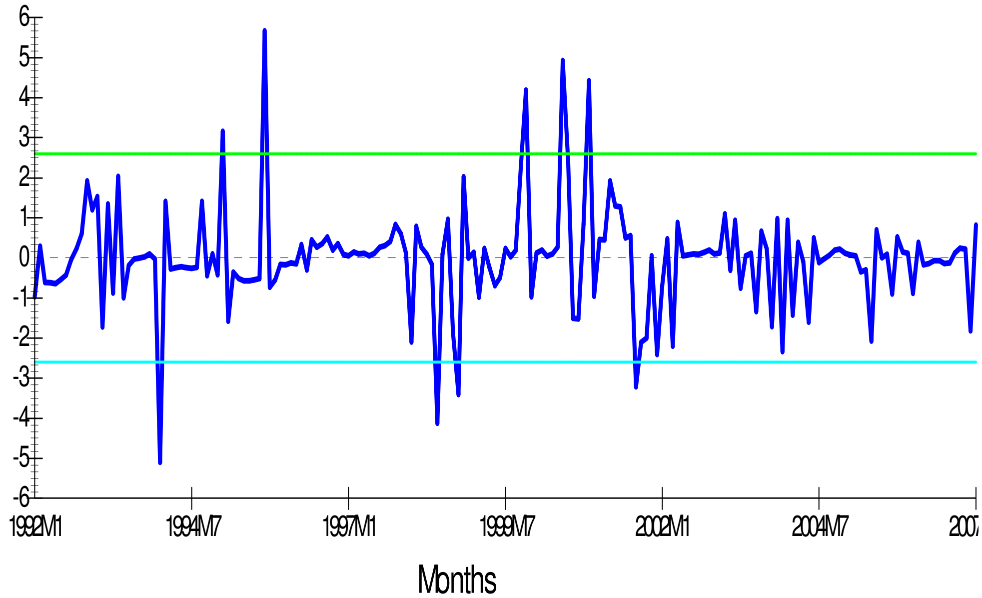
**Plot of Actual and Fitted Values of Table 5.3.1b**



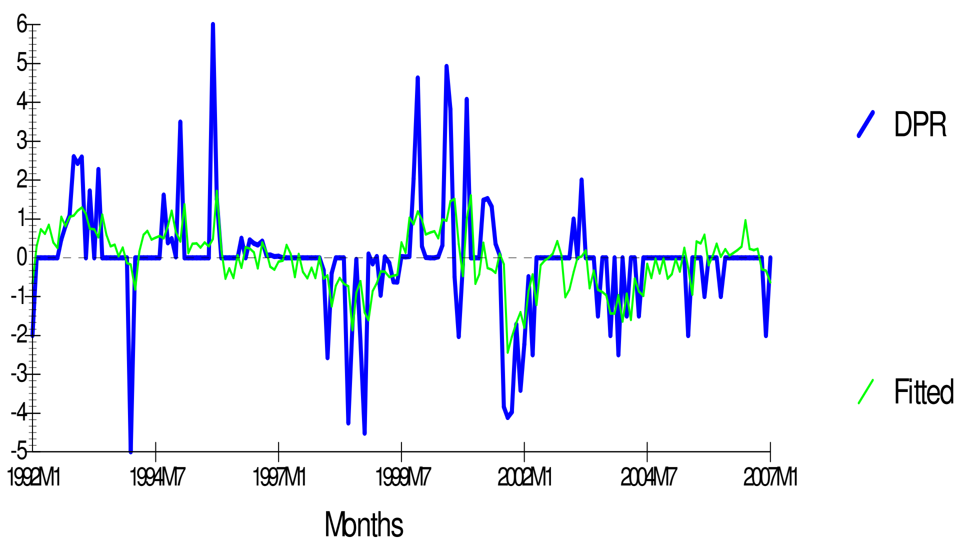

**Plot of Actual and Fitted Values of Table 5.3.2**



## Plot of Residuals and Two Standard Error Bands of Table 5.3.2




## Plot of Actual and Fitted Values of Table 5.3.3



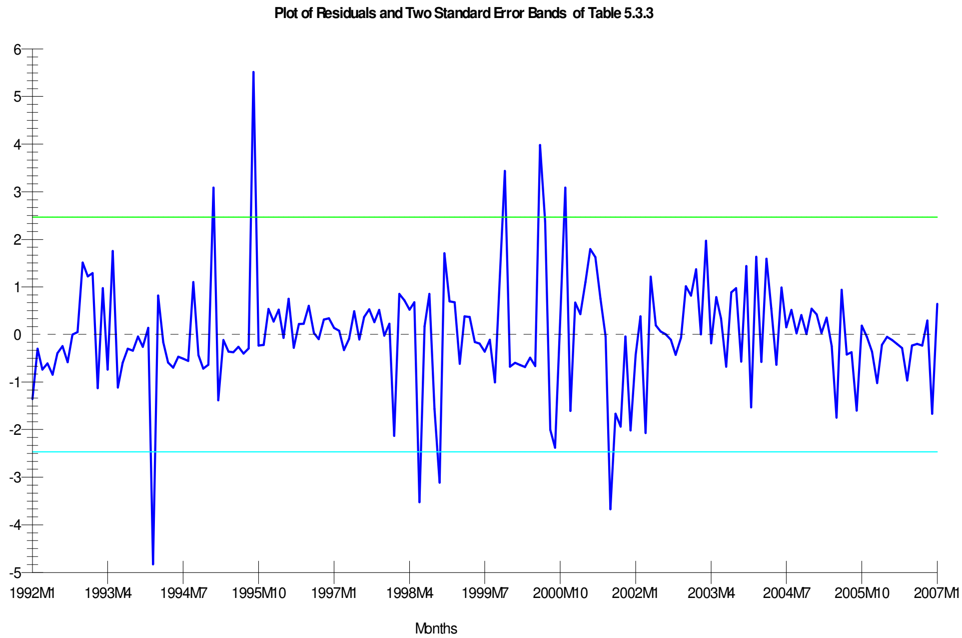



**Table I A: Unit root tests for variable SPREAD**
The Dickey-Fuller regressions include an intercept but not a trend
Sample period from 1992M2 to 2007M1

| | Test Statistic | LL | AIC | SBC | HQC |
|---|---|---|---|---|---|
| DF | -3.6205 | -341.6477 | -343.6477 | -346.8406 | -344.9423 |
| ADF(1) | -3.2759 | -341.1728 | -344.1728 | -348.9622 | -346.1147 |
| ADF(2) | -3.1614 | -341.1635 | -345.1635 | -351.5494 | -347.7527 |
| ADF(3) | -3.3555 | -340.4185 | -345.4185 | -353.4008 | -348.6550 |
| ADF(4) | -3.5650 | -339.6150 | -345.6150 | -355.1938 | -349.4988 |
| ADF(5) | -3.4306 | -339.6150 | -346.6150 | -357.7903 | -351.1461 |
| ADF(6) | -3.3243 | -339.6129 | -347.6129 | -360.3847 | -352.7913 |
| ADF(7) | -3.4357 | -339.2094 | -348.2094 | -362.5778 | -354.0352 |
| ADF(8) | -3.5072 | -338.9175 | -348.9175 | -364.8823 | -355.3905 |
| ADF(9) | -3.4163 | -338.9040 | -349.9040 | -367.4652 | -357.0243 |
| ADF(10) | -2.9189 | -337.6556 | -349.6556 | -368.8133 | -357.4232 |
| ADF(11) | -3.0266 | -337.2900 | -350.2900 | -371.0442 | -358.7050 |
| ADF(12) | -3.1351 | -335.4431 | -349.4431 | -371.7938 | -358.5054 |

95% critical value for the augmented Dickey-Fuller statistic = -2.8776

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

**Table I B: Unit root tests for variable SPREAD**

The Dickey-Fuller regressions include an intercept and a linear trend
Sample period from 1992M2 to 2007M1

| | Test Statistic | LL | AIC | SBC | HQC |
|---|---|---|---|---|---|
| DF | -3.5744 | -341.5916 | -344.5916 | -349.3811 | -346.5335 |
| ADF(1) | -3.2055 | -341.1448 | -345.1448 | -351.5307 | -347.7340 |
| ADF(2) | -3.0846 | -341.1380 | -346.1380 | -354.1204 | -349.3745 |
| ADF(3) | -3.2874 | -340.3730 | -346.3730 | -355.9518 | -350.2568 |
| ADF(4) | -3.5080 | -339.5386 | -346.5386 | -357.7140 | -351.0698 |
| ADF(5) | -3.3758 | -339.5382 | -347.5382 | -360.3101 | -352.7167 |
| ADF(6) | -3.2715 | -339.5341 | -348.5341 | -362.9024 | -354.3598 |
| ADF(7) | -3.3921 | -339.1029 | -349.1029 | -365.0677 | -355.5759 |
| ADF(8) | -3.4727 | -338.7829 | -349.7829 | -367.3442 | -356.9033 |
| ADF(9) | -3.3861 | -338.7621 | -350.7621 | -369.9198 | -358.5297 |
| ADF(10) | -2.8753 | -337.5682 | -350.5682 | -371.3224 | -358.9832 |
| ADF(11) | -2.9937 | -337.1721 | -351.1721 | -373.5228 | -360.2343 |
| ADF(12) | -3.0926 | -335.3202 | -350.3202 | -374.2674 | -360.0298 |

Note

95% critical value for the augmented Dickey-Fuller statistic = -3.4356

LL = Maximized log-likelihood  AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion  HQC = Hannan-Quinn Criterion

**Table II. Asymptotic critical value bounds for the *F*-statistic. Testing for the existence of a levels relationship**

**Case III: Unrestricted intercept and no trend**

| | 0.100 | | 0.050 | | 0.025 | | 0.010 | | Mean | | Variance | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $k$ | $I(0)$ | $I(1)$ | $I(0)$ | $I(1)$ | $I(0)$ | $I(1)$ | $I(0)$ | $I(1)$ | $I(0)$ | $I(1)$ | $I(0)$ | $I(1)$ |
| 0 | 6.58 | 6.58 | 8.21 | 8.21 | 9.80 | 9.80 | 11.79 | 11.79 | 3.05 | 3.05 | 7.07 | 7.07 |
| 1 | 4.04 | 4.78 | 4.94 | 5.73 | 5.77 | 6.68 | 6.84 | 7.84 | 2.03 | 2.52 | 2.28 | 2.89 |
| 2 | 3.17 | 4.14 | 3.79 | 4.85 | 4.41 | 5.52 | 5.15 | 6.36 | 1.69 | 2.35 | 1.23 | 1.77 |
| 3 | 2.72 | 3.77 | 3.23 | 4.35 | 3.69 | 4.89 | 4.29 | 5.61 | 1.51 | 2.26 | 0.82 | 1.27 |
| 4 | 2.45 | 3.52 | 2.86 | 4.01 | 3.25 | 4.49 | 3.74 | 5.06 | 1.41 | 2.21 | 0.60 | 0.98 |
| 5 | 2.26 | 3.35 | 2.62 | 3.79 | 2.96 | 4.18 | 3.41 | 4.68 | 1.34 | 2.17 | 0.48 | 0.79 |
| 6 | 2.12 | 3.23 | 2.45 | 3.61 | 2.75 | 3.99 | 3.15 | 4.43 | 1.29 | 2.14 | 0.39 | 0.66 |
| 7 | 2.03 | 3.13 | 2.32 | 3.50 | 2.60 | 3.84 | 2.96 | 4.26 | 1.26 | 2.13 | 0.33 | 0.58 |
| 8 | 1.95 | 3.06 | 2.22 | 3.39 | 2.48 | 3.70 | 2.79 | 4.10 | 1.23 | 2.12 | 0.29 | 0.51 |
| 9 | 1.88 | 2.99 | 2.14 | 3.30 | 2.37 | 3.60 | 2.65 | 3.97 | 1.21 | 2.10 | 0.25 | 0.45 |
| 10 | 1.83 | 2.94 | 2.06 | 3.24 | 2.28 | 3.50 | 2.54 | 3.86 | 1.19 | 2.09 | 0.23 | 0.41 |

Source: Pesaran, H. M.; Shin, Y. and Smith, R. J.; (2001, p. 300)

**Table III. Asymptotic critical value bounds of the *t*-statistic. Testing for the existence of a levels relationship**

**Case III: Unrestricted intercept and no trend**

| | **0.100** | | **0.050** | | **0.025** | | **0.010** | | **Mean** | | **Variance** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***k*** | ***I*(0)** | ***I*(1)** | ***I*(0)** | ***I*(1)** | ***I*(0)** | ***I*(1)** | ***I*(0)** | ***I*(1)** | ***I*(0)** | ***I*(1)** | ***I*(0)** | ***I*(1)** |
| 0 | -2.57 | -2.57 | -2.86 | -2.86 | -3.13 | -3.13 | -3.43 | -3.43 | -1.53 | -1.53 | 0.72 | 0.71 |
| 1 | -2.57 | -2.91 | -2.86 | -3.22 | -3.13 | -3.50 | -3.43 | -3.82 | -1.53 | -1.80 | 0.72 | 0.81 |
| 2 | -2.57 | -3.21 | -2.86 | -3.53 | -3.13 | -3.80 | -3.43 | -4.10 | -1.53 | -2.04 | 0.72 | 0.86 |
| 3 | -2.57 | -3.46 | -2.86 | -3.78 | -3.13 | -4.05 | -3.43 | -4.37 | -1.53 | -2.26 | 0.72 | 0.89 |
| 4 | -2.57 | -3.66 | -2.86 | -3.99 | -3.13 | -4.26 | -3.43 | -4.60 | -1.53 | -2.47 | 0.72 | 0.91 |
| 5 | -2.57 | -3.86 | -2.86 | -4.19 | -3.13 | -4.46 | -3.43 | -4.79 | -1.53 | -2.65 | 0.72 | 0.92 |
| 6 | -2.57 | -4.04 | -2.86 | -4.38 | -3.13 | -4.66 | -3.43 | -4.99 | -1.53 | -2.83 | 0.72 | 0.93 |
| 7 | -2.57 | -4.23 | -2.86 | -4.57 | -3.13 | -4.85 | -3.43 | -5.19 | -1.53 | -3.00 | 0.72 | 0.94 |
| 8 | -2.57 | -4.40 | -2.86 | -4.72 | -3.13 | -5.02 | -3.43 | -5.37 | -1.53 | -3.16 | 0.72 | 0.96 |
| 9 | -2.57 | -4.56 | -2.86 | -4.88 | -3.13 | -5.18 | -3.42 | -5.54 | -1.53 | -3.31 | 0.72 | 0.96 |
| 10 | -2.57 | -4.69 | -2.86 | -5.03 | -3.13 | -5.34 | -3.43 | -5.68 | -1.53 | -3.46 | 0.72 | 0.96 |

Source: Pesaran, H. M.; Shin, Y. and Smith, R. J.; (2001, p. 303)

**Table IV**
**VAR Choice of the Number of Cointegrating Relations Using Model Selection Criteria**

Sample from 1992M1 to 2007M1. Order of VAR = 1.
List of variables included in the cointegrating vector:
TMTDR PR
List of eigenvalues in descending order:
0.11629 0.0013626

| Rank | Maximized LL | AIC | SBC | HQC |
|---|---|---|---|---|
| r = 0 | -618.7647 | -620.7647 | -623.9632 | -622.0615 |
| r = 1 | -607.5764 | -612.5764 | -620.5726 | -615.8183 |
| r = 2 | -607.4530 | -613.4530 | -623.0485 | -617.3432 |

Note:

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

**Table V: Test Statistics and Choice Criteria for Selecting the Order of the VAR Model**

Sample from 1992 M1 to 2007M1. Order of VAR = 12
List of variables included in the unrestricted VAR:
TMTDR
List of deterministic and/or exogenous variables:
C PR

| Order | LL | AIC | SBC | | LR test | Adjusted LR test |
|---|---|---|---|---|---|---|
| 12 | -282.7609 | -296.7609 | -319.1504 | | ------ | ------ |
| 11 | -282.8134 | -295.8134 | -316.6037 | CHSQ( 1)= | 0.10511[0.746] | 0.096979[0.755] |
| 10 | -283.9269 | -295.9269 | -315.1178 | CHSQ( 2)= | 2.3320[0.312] | 2.1516[0.341] |
| 9 | -283.9269 | -294.9269 | -312.5186 | CHSQ( 3)= | 2.3320[0.506] | 2.1516[0.542] |
| 8 | -283.9297 | -293.9297 | -309.9222 | CHSQ( 4)= | 2.3377[0.674] | 2.1569[0.707] |
| 7 | -283.9299 | -292.9299 | -307.3231 | CHSQ( 5)= | 2.3380[0.801] | 2.1572[0.827] |
| 6 | -283.9491 | -291.9491 | -304.7431 | CHSQ( 6)= | 2.3764[0.882] | 2.1926[0.901] |
| 5 | -283.9515 | -290.9515 | -302.1463 | CHSQ( 7)= | 2.3813[0.936] | 2.1971[0.948] |
| 4 | -284.7150 | -290.7150 | -300.3105 | CHSQ( 8)= | 3.9083[0.865] | 3.6060[0.891] |
| 3 | -286.2386 | -291.2386 | -299.2349 | CHSQ( 9)= | 6.9555[0.642] | 6.4175[0.698] |
| 2 | -287.9025 | -291.9025 | -298.2995 | CHSQ( 10)= | 10.2832[0.416] | 9.4878[0.487] |
| **1** | **-288.7020** | **-291.7020** | **-296.4998** | **CHSQ( 11)=** | **11.8823[0.373]** | **10.9632[0.446]** |
| 0 | -464.4053 | -466.4053 | -469.6038 | CHSQ( 12)= | 363.2889[0.000] | 335.1892[0.000] |

Note:

LL = Maximized log-likelihood AIC=Akaike Information Criterion

SBC=Schwarz Bayesian Criterion

**Table VIA: Test Statistics and Choice Criteria for Selecting the Order of the VAR Model**

Sample from 1992M1 to 2007M1. Order of VAR = 12
List of variables included in the unrestricted VAR:
LLRCPS ANF1M LREER PR
List of deterministic and/or exogenous variables:
C

| Order | LL | AIC | SBC | LR test | Adjusted LR test |
|---|---|---|---|---|---|
| 12 | -222.1103 | -418.1103 | -731.5630 | ------ | ------ |
| 11 | -226.9640 | -406.9640 | -694.8287 | CHSQ( 16)= 9.7073[0.881] | 7.0793[0.972] |
| 10 | -231.2047 | -395.2047 | -657.4815 | CHSQ( 32)= 18.1888[0.976] | 13.2647[0.999] |
| 9 | -239.6125 | -387.6125 | -624.3012 | CHSQ( 48)= 35.0043[0.919] | 25.5280[0.997] |
| 8 | -249.0132 | -381.0132 | -592.1140 | CHSQ( 64)= 53.8058[0.814] | 39.2396[0.994] |
| 7 | -259.2910 | -375.2910 | -560.8039 | CHSQ( 80)= 74.3614[0.657] | 54.2304[0.988] |
| 6 | -268.8709 | -368.8709 | -528.7958 | CHSQ( 96)= 93.5212[0.553] | 68.2033[0.986] |
| 5 | -274.2404 | -358.2404 | -492.5772 | CHSQ(112)= 104.2601[0.686] | 76.0350[0.996] |
| 4 | -284.3916 | -352.3916 | -461.1405 | CHSQ(128)= 124.5625[0.569] | 90.8412[0.995] |
| 3 | -298.5971 | -350.5971 | -433.7580 | CHSQ(144)= 152.9735[0.289] | 111.5608[0.979] |
| **2** | **-307.0681** | **-343.0681** | **-400.6410** | **CHSQ(160)= 169.9155[0.281]** | **123.9163[0.984]** |
| 1 | -353.9408 | -373.9408 | -405.9257 | CHSQ(176)= 263.6609[0.000] | 192.2831[0.190] |
| 0 | -1429.0 | -1433.0 | -1439.4 | CHSQ(192)= 2413.7[0.000] | 1760.3[0.000] |

Note:

LL = Maximized log-likelihood AIC=Akaike Information Criterion

SBC=Schwarz Bayesian Criterion

**Table VIB: Test Statistics and Choice Criteria for Selecting the Order of the VAR Model**

Sample from 1992M1 to 2007M1. Order of VAR = 12
List of variables included in the unrestricted VAR:
LLRCPS ANF1M LREER PR TMTDR
List of deterministic and/or exogenous variables:
C

| Order | LL | AIC | SBC | LR test | Adjusted LR test |
|---|---|---|---|---|---|
| 12 | -412.9784 | -717.9784 | -1205.7 | ------ | ------ |
| 11 | -425.5505 | -705.5505 | -1153.3 | CHSQ( 25)= 25.1440[0.454] | 16.6701[0.893] |
| 10 | -436.7978 | -691.7978 | -1099.6 | CHSQ( 50)= 47.6388[0.569] | 31.5837[0.981] |
| 9 | -452.7986 | -682.7986 | -1050.6 | CHSQ( 75)= 79.6403[0.335] | 52.8002[0.976] |
| 8 | -466.8318 | -671.8318 | -999.6777 | CHSQ(100)= 107.7066[0.281] | 71.4077[0.986] |
| 7 | -482.4736 | -662.4736 | -950.3383 | CHSQ(125)= 138.9903[0.185] | 92.1483[0.988] |
| 6 | -495.8507 | -650.8507 | -898.7342 | CHSQ(150)= 165.7444[0.180] | 109.8858[0.994] |
| 5 | -509.0834 | -639.0834 | -846.9857 | CHSQ(175)= 192.2099[0.177] | 127.4320[0.997] |
| 4 | -528.7320 | -633.7320 | -801.6531 | CHSQ(200)= 231.5071[0.063] | 153.4854[0.994] |
| 3 | -548.6067 | -628.6067 | -756.5466 | CHSQ(225)= 271.2566[0.019] | 179.8386[0.988] |
| **2** | **-567.0268** | **-622.0268** | **-709.9854** | **CHSQ(250)= 308.0966[0.007]** | **204.2630[0.984]** |
| 1 | -633.4480 | -663.4480 | -711.4255 | CHSQ(275)= 440.9392[0.000] | 292.3354[0.226] |
| 0 | -1852.5 | -1857.5 | -1865.5 | CHSQ(300)= 2879.1[0.000] | 1908.8[0.000] |

Note:

LL = Maximized log-likelihood AIC=Akaike Information Criterion

SBC=Schwarz Bayesian Criterion

**Table VIC: Test Statistics and Choice Criteria for Selecting the Order of the VAR Model**

Sample from 1992M1 to 2007M1. Order of VAR = 12
List of variables included in the unrestricted VAR:
LLRCPS ANF1M LREER PR TMTDR ANRMO21M
List of deterministic and/or exogenous variables: C

| Order | LL | AIC | SBC | LR test | Adjusted LR test |
|---|---|---|---|---|---|
| 12 | -1197.9 | -1635.9 | -2336.4 | ------ | ------ |
| 11 | -1230.8 | -1632.8 | -2275.7 | CHSQ( 36)= 65.8064[0.002] | 39.2657[0.326] |
| 10 | -1257.5 | -1623.5 | -2208.9 | CHSQ( 72)= 119.2536[0.000] | 71.1569[0.506] |
| 9 | -1288.1 | -1618.1 | -2145.8 | CHSQ(108)= 180.2961[0.000] | 107.5800[0.493] |
| 8 | -1325.7 | -1619.7 | -2089.9 | CHSQ(144)= 255.5772[0.000] | 152.4991[0.298] |
| 7 | -1349.6 | -1607.6 | -2020.2 | CHSQ(180)= 303.3543[0.000] | 181.0070[0.465] |
| 6 | -1368.7 | -1590.7 | -1945.7 | CHSQ(216)= 341.5407[0.000] | 203.7923[0.714] |
| 5 | -1387.9 | -1573.9 | -1871.4 | CHSQ(252)= 380.0223[0.000] | 226.7536[0.872] |
| 4 | -1414.5 | -1564.5 | -1804.4 | CHSQ(288)= 433.2474[0.000] | 258.5122[0.893] |
| 3 | -1442.0 | -1556.0 | -1738.3 | CHSQ(324)= 488.1919[0.000] | 291.2968[0.904] |
| **2** | **-1471.8** | **-1549.8** | **-1674.5** | **CHSQ(360)= 547.7481[0.000]** | **326.8331[0.895]** |
| 1 | -1555.7 | -1597.7 | -1664.8 | CHSQ(396)= 715.5165[0.000] | 426.9380[0.137] |
| 0 | -2794.9 | -2800.9 | -2810.5 | CHSQ(432)= 3193.9[0.000] | 1905.8[0.000] |

Note:

LL = Maximized log-likelihood AIC=Akaike Information Criterion

SBC=Schwarz Bayesian Criterion

**Table VII**

Ordinary Least Squares Estimation

Dependent variable is TMTDR

Sample from 1992M1 to 2007M1

**Diagnostic Tests**

| | | | |
|---|---|---|---|
| R-Squared | 0.98545 | R-Bar-Squared | 0.98503 |
| S.E. of Regression | 1.0991 | F-stat. F( 5, 175) | 2370.3[0.000] |

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ( 12)= 17.1159[0.145] | F( 12, 163)= 1.4186[0.162] |
| Functional Form | CHSQ( 1)= 0.011053[0.916] | F( 1, 174)= 0.010627[0.918] |
| Normality | CHSQ( 2)= 334.4077[0.000] | Not applicable |
| Heteroscedasticity | CHSQ( 1)= 0.10434[0.747] | F( 1, 179)= 0.10325[0.748] |

**Data and Variables**

| Variables / Date | Total Reserve Minus Gold (Millions of US $) | Reserve Money (Billions of Cedis) | G old Prices (US $ Per Ounce) | Cocoa Prices (US $ Per Tonne) |
|---|---|---|---|---|
| 1992M1 | 607.034 | 13.758 | 1281.570 | 354.701 |
| 1992M2 | 591.118 | 14.475 | 1191.050 | 353.780 |
| 1992M3 | 524.484 | 12.938 | 1127.960 | 344.183 |
| 1992M4 | 514.851 | 14.239 | 1045.480 | 338.692 |
| 1992M5 | 518.817 | 13.852 | 995.310 | 337.099 |
| 1992M6 | 409.505 | 13.907 | 962.630 | 341.022 |
| 1992M7 | 413.644 | 13.896 | 1105.240 | 352.254 |
| 1992M8 | 423.773 | 13.333 | 1182.110 | 342.893 |
| 1992M9 | 399.952 | 13.974 | 1118.930 | 345.007 |
| 1992M10 | 431.304 | 16.234 | 1071.480 | 344.892 |
| 1992M11 | 379.187 | 19.479 | 1076.380 | 335.051 |
| 1992M12 | 319.911 | 24.584 | 1034.900 | 334.807 |
| 1993M1 | 332.025 | 25.045 | 1035.570 | 329.031 |
| 1993M2 | 304.733 | 23.738 | 990.990 | 329.300 |
| 1993M3 | 329.257 | 19.072 | 977.320 | 330.097 |
| 1993M4 | 278.958 | 20.714 | 1010.750 | 342.057 |
| 1993M5 | 251.912 | 20.399 | 998.070 | 366.668 |
| 1993M6 | 219.588 | 21.629 | 941.690 | 371.810 |
| 1993M7 | 367.657 | 22.441 | 1058.640 | 392.400 |
| 1993M8 | 349.502 | 21.857 | 1087.170 | 378.700 |
| 1993M9 | 312.502 | 21.496 | 1263.300 | 354.400 |
| 1993M10 | 291.852 | 22.394 | 1290.470 | 362.380 |
| 1993M11 | 323.347 | 22.135 | 1321.780 | 374.168 |
| 1993M12 | 409.681 | 25.789 | 1359.510 | 383.302 |
| 1994M1 | 356.041 | 24.870 | 1263.630 | 387.078 |
| 1994M2 | 345.127 | 24.321 | 1226.590 | 382.305 |
| 1994M3 | 354.605 | 25.414 | 1307.190 | 383.878 |

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|---|---|---|---|---|
| 1994M4 | 384.643 | 25.267 | 1244.000 | 377.321 |
| 1994M5 | 351.360 | 26.494 | 1378.690 | 381.590 |
| 1994M6 | 443.803 | 28.018 | 1458.950 | 385.743 |
| 1994M7 | 491.995 | 29.861 | 1555.870 | 385.400 |
| 1994M8 | 583.632 | 30.018 | 1551.170 | 380.761 |
| 1994M9 | 569.547 | 31.019 | 1486.260 | 391.928 |
| 1994M10 | 628.888 | 33.894 | 1447.710 | 389.594 |
| 1994M11 | 588.059 | 35.837 | 1430.620 | 384.441 |
| 1994M12 | 583.874 | 46.128 | 1397.510 | 379.400 |
| 1995M1 | 646.675 | 43.044 | 1467.560 | 378.550 |
| 1995M2 | 621.995 | 41.211 | 1510.630 | 376.505 |
| 1995M3 | 653.458 | 40.941 | 1484.930 | 381.662 |
| 1995M4 | 638.852 | 41.319 | 1463.970 | 391.044 |
| 1995M5 | 515.384 | 41.296 | 1448.410 | 385.219 |
| 1995M6 | 451.024 | 44.966 | 1437.170 | 387.490 |
| 1995M7 | 487.881 | 42.382 | 1360.760 | 386.240 |
| 1995M8 | 483.353 | 43.109 | 1410.490 | 383.698 |
| 1995M9 | 654.042 | 42.021 | 1395.080 | 383.217 |
| 1995M10 | 733.803 | 51.617 | 1394.640 | 383.069 |
| 1995M11 | 679.908 | 58.636 | 1435.900 | 385.676 |
| 1995M12 | 697.465 | 62.314 | 1380.960 | 387.558 |
| 1996M1 | 681.998 | 59.313 | 1349.110 | 400.071 |
| 1996M2 | 692.606 | 58.081 | 1370.550 | 404.484 |
| 1996M3 | 713.348 | 57.959 | 1338.600 | 396.326 |
| 1996M4 | 739.460 | 58.229 | 1457.330 | 393.145 |
| 1996M5 | 644.368 | 60.091 | 1524.440 | 391.943 |
| 1996M6 | 714.468 | 59.828 | 1537.560 | 385.272 |
| 1996M7 | 658.286 | 62.356 | 1490.380 | 383.586 |
| 1996M8 | 640.146 | 63.687 | 1501.720 | 387.471 |
| 1996M9 | 656.016 | 65.145 | 1475.950 | 382.965 |
| 1996M10 | 761.153 | 79.561 | 1477.580 | 381.073 |
| 1996M11 | 769.786 | 80.005 | 1465.540 | 378.517 |

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|---|---|---|---|---|
| 1996M12 | 828.725 | 90.216 | 1474.230 | 368.978 |
| 1997M1 | 597.142 | 88.560 | 1428.790 | 355.200 |
| 1997M2 | 630.090 | 90.547 | 1373.280 | 346.713 |
| 1997M3 | 617.088 | 85.122 | 1521.880 | 351.805 |
| 1997M4 | 627.537 | 84.709 | 1570.610 | 344.583 |
| 1997M5 | 559.310 | 86.984 | 1568.300 | 343.703 |
| 1997M6 | 537.716 | 86.767 | 1693.620 | 340.476 |
| 1997M7 | 483.098 | 92.818 | 1677.430 | 324.089 |
| 1997M8 | 427.462 | 92.994 | 1649.190 | 324.050 |
| 1997M9 | 468.067 | 87.371 | 1765.580 | 324.476 |
| 1997M10 | 499.732 | 101.846 | 1741.100 | 323.883 |
| 1997M11 | 480.373 | 108.970 | 1696.370 | 305.346 |
| 1997M12 | 537.824 | 120.308 | 1738.750 | 287.620 |
| 1998M1 | 502.280 | 118.538 | 1670.670 | 289.500 |
| 1998M2 | 498.110 | 115.708 | 1643.230 | 297.455 |
| 1998M3 | 494.177 | 112.548 | 1721.060 | 295.955 |
| 1998M4 | 493.563 | 110.194 | 1720.160 | 308.285 |
| 1998M5 | 493.823 | 108.817 | 1781.410 | 298.979 |
| 1998M6 | 351.650 | 112.156 | 1723.350 | 292.539 |
| 1998M7 | 364.966 | 116.433 | 1712.240 | 292.752 |
| 1998M8 | 356.032 | 112.038 | 1682.500 | 284.110 |
| 1998M9 | 330.695 | 109.585 | 1685.860 | 288.982 |
| 1998M10 | 327.551 | 118.713 | 1647.520 | 295.715 |
| 1998M11 | 321.642 | 128.826 | 1599.910 | 293.717 |
| 1998M12 | 376.980 | 151.800 | 1524.120 | 291.679 |
| 1999M1 | 384.488 | 143.509 | 1455.790 | 286.937 |
| 1999M2 | 360.195 | 137.438 | 1411.140 | 287.655 |
| 1999M3 | 382.541 | 136.526 | 1313.890 | 286.214 |
| 1999M4 | 396.080 | 136.092 | 1177.890 | 282.618 |
| 1999M5 | 340.397 | 133.332 | 1059.240 | 276.910 |
| 1999M6 | 378.748 | 139.891 | 1162.910 | 261.314 |
| 1999M7 | 385.781 | 146.178 | 1113.240 | 256.693 |

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|---|---|---|---|---|
| 1999M8 | 344.616 | 152.962 | 1003.570 | 256.905 |
| 1999M9 | 349.514 | 143.754 | 1060.560 | 264.311 |
| 1999M10 | 340.557 | 158.740 | 1021.540 | 310.782 |
| 1999M11 | 435.872 | 179.822 | 922.080 | 293.184 |
| 1999M12 | 453.774 | 210.164 | 918.750 | 282.953 |
| 2000M1 | 432.906 | 206.682 | 918.480 | 284.066 |
| 2000M2 | 420.052 | 197.791 | 860.740 | 299.715 |
| 2000M3 | 410.751 | 206.510 | 925.930 | 286.924 |
| 2000M4 | 289.954 | 219.190 | 911.950 | 279.653 |
| 2000M5 | 342.696 | 220.631 | 909.420 | 276.741 |
| 2000M6 | 396.300 | 222.404 | 948.230 | 285.732 |
| 2000M7 | 240.424 | 238.010 | 967.110 | 281.586 |
| 2000M8 | 224.609 | 245.497 | 877.790 | 274.425 |
| 2000M9 | 237.232 | 248.534 | 882.730 | 273.530 |
| 2000M10 | 203.982 | 268.245 | 877.720 | 269.929 |
| 2000M11 | 210.468 | 292.177 | 873.990 | 266.297 |
| 2000M12 | 232.055 | 324.713 | 892.780 | 271.450 |
| 2001M1 | 205.420 | 354.643 | 966.390 | 265.486 |
| 2001M2 | 143.273 | 345.111 | 1157.470 | 262.089 |
| 2001M3 | 163.800 | 323.138 | 1124.410 | 263.027 |
| 2001M4 | 161.316 | 318.939 | 1083.660 | 260.331 |
| 2001M5 | 120.474 | 344.500 | 1077.440 | 272.093 |
| 2001M6 | 123.115 | 349.924 | 973.290 | 270.202 |
| 2001M7 | 174.497 | 387.730 | 965.320 | 267.526 |
| 2001M8 | 234.444 | 345.867 | 1032.480 | 272.092 |
| 2001M9 | 230.774 | 371.538 | 1026.200 | 284.472 |
| 2001M10 | 207.531 | 373.392 | 1084.860 | 282.267 |
| 2001M11 | 240.002 | 427.143 | 1231.550 | 277.184 |
| 2001M12 | 298.240 | 458.001 | 1337.430 | 275.836 |
| 2002M1 | 293.680 | 446.223 | 1385.930 | 281.000 |
| 2002M2 | 233.537 | 417.320 | 1490.390 | 295.288 |
| 2002M3 | 289.843 | 414.128 | 1592.030 | 294.048 |

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|---|---|---|---|---|
| 2002M4 | 256.702 | 419.981 | 1568.150 | 302.683 |
| 2002M5 | 306.123 | 424.334 | 1604.700 | 314.493 |
| 2002M6 | 287.331 | 427.973 | 1656.460 | 321.178 |
| 2002M7 | 291.257 | 447.205 | 1872.000 | 313.291 |
| 2002M8 | 318.720 | 464.990 | 1959.270 | 310.281 |
| 2002M9 | 370.021 | 452.539 | 2167.410 | 319.136 |
| 2002M10 | 484.847 | 511.868 | 2201.500 | 316.557 |
| 2002M11 | 454.091 | 565.999 | 1825.060 | 320.436 |
| 2002M12 | 539.747 | 669.599 | 2025.610 | 332.036 |
| 2003M1 | 529.900 | 589.063 | 2190.140 | 356.859 |
| 2003M2 | 510.732 | 567.902 | 2230.350 | 358.970 |
| 2003M3 | 510.199 | 548.582 | 1989.840 | 340.600 |
| 2003M4 | 529.965 | 565.485 | 1932.140 | 328.200 |
| 2003M5 | 594.893 | 587.018 | 1729.210 | 355.700 |
| 2003M6 | 788.340 | 591.272 | 1579.110 | 356.400 |
| 2003M7 | 786.869 | 582.664 | 1556.870 | 351.000 |
| 2003M8 | 847.469 | 602.501 | 1565.550 | 359.800 |
| 2003M9 | 906.186 | 599.567 | 1625.390 | 379.000 |
| 2003M10 | 1047.220 | 661.097 | 1481.680 | 378.900 |
| 2003M11 | 1314.940 | 704.831 | 1510.010 | 389.900 |
| 2003M12 | 1352.810 | 857.805 | 1646.580 | 407.000 |
| 2004M1 | 1298.680 | 1011.660 | 1626.400 | 413.800 |
| 2004M2 | 1304.920 | 765.048 | 1566.090 | 404.900 |
| 2004M3 | 1255.930 | 748.046 | 1504.430 | 406.700 |
| 2004M4 | 1345.810 | 817.759 | 1435.670 | 403.300 |
| 2004M5 | 1338.450 | 790.119 | 1413.040 | 383.800 |
| 2004M6 | 1287.900 | 790.307 | 1404.710 | 392.400 |
| 2004M7 | 1404.430 | 790.461 | 1567.860 | 398.100 |
| 2004M8 | 1277.360 | 788.402 | 1727.330 | 400.500 |
| 2004M9 | 1353.430 | 787.576 | 1541.140 | 405.300 |
| 2004M10 | 1425.170 | 822.100 | 1483.800 | 420.500 |
| 2004M11 | 1608.060 | 897.071 | 1665.710 | 439.400 |

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|---|---|---|---|---|
| 2004M12 | 1626.650 | 1011.660 | 1672.750 | 442.100 |
| 2005M1 | 1570.180 | 909.760 | 1549.890 | 424.000 |
| 2005M2 | 1518.960 | 882.140 | 1719.460 | 423.400 |
| 2005M3 | 1439.780 | 888.353 | 1763.910 | 433.900 |
| 2005M4 | 1429.220 | 898.274 | 1585.950 | 429.200 |
| 2005M5 | 1345.320 | 894.166 | 1509.460 | 421.900 |
| 2005M6 | 1347.780 | 886.352 | 1538.630 | 430.700 |
| 2005M7 | 1306.680 | 893.951 | 1488.320 | 424.500 |
| 2005M8 | 1340.520 | 960.297 | 1482.230 | 437.900 |
| 2005M9 | 1525.400 | 950.651 | 1504.160 | 456.000 |
| 2005M10 | 1520.170 | 992.548 | 1453.830 | 469.900 |
| 2005M11 | 1558.450 | 1050.300 | 1428.780 | 476.700 |
| 2005M12 | 1752.900 | 1080.380 | 1511.320 | 510.100 |
| 2006M1 | 1789.380 | 1074.480 | 1576.230 | 549.864 |
| 2006M2 | 1776.250 | 1034.710 | 1546.370 | 555.000 |
| 2006M3 | 1697.940 | 1006.730 | 1545.050 | 557.100 |
| 2006M4 | 1759.040 | 1042.320 | 1552.340 | 610.700 |
| 2006M5 | 1696.010 | 1084.800 | 1594.300 | 675.400 |
| 2006M6 | 1823.560 | 1041.530 | 1605.780 | 596.100 |
| 2006M7 | 1879.940 | 1124.940 | 1673.210 | 633.700 |
| 2006M8 | 1693.380 | 1086.710 | 1612.940 | 632.600 |
| 2006M9 | 1635.190 | 1081.200 | 1566.340 | 598.200 |
| 2006M10 | 1963.700 | 1164.980 | 1530.170 | 585.800 |
| 2006M11 | 1884.070 | 1279.930 | 1582.540 | 627.800 |
| 2006M12 | 2090.290 | 1469.100 | 1702.160 | 629.800 |
| 2007M1 | 1924.800 | 1347.340 | 1701.930 | 631.200 |

**Data and Variables**

| Variables / Date | US Consumer Price Index | Broad Money (Billions of Cedis) | Three Month Time Deposit Rate | Claims On Private Sector (Billions of Cedis) |
|---|---|---|---|---|
| 1992M1 | 80.197 | 36.627 | 17.480 | 9.497 |
| 1992M2 | 80.488 | 38.622 | 16.920 | 9.512 |
| 1992M3 | 80.894 | 39.600 | 16.020 | 10.070 |
| 1992M4 | 81.011 | 40.764 | 16.230 | 10.489 |
| 1992M5 | 81.127 | 40.386 | 15.810 | 10.836 |
| 1992M6 | 81.417 | 42.610 | 15.460 | 11.310 |
| 1992M7 | 81.591 | 43.701 | 15.420 | 11.830 |
| 1992M8 | 81.824 | 44.526 | 15.540 | 12.118 |
| 1992M9 | 82.056 | 45.786 | 15.630 | 13.111 |
| 1992M10 | 82.346 | 47.669 | 16.580 | 13.552 |
| 1992M11 | 82.462 | 52.731 | 17.270 | 13.853 |
| 1992M12 | 82.404 | 57.532 | 17.520 | 13.852 |
| 1993M1 | 82.811 | 61.041 | 19.650 | 13.977 |
| 1993M2 | 83.101 | 59.614 | 20.710 | 14.958 |
| 1993M3 | 83.391 | 59.721 | 19.260 | 15.745 |
| 1993M4 | 83.624 | 59.988 | 22.900 | 15.591 |
| 1993M5 | 83.740 | 59.428 | 23.140 | 16.357 |
| 1993M6 | 83.856 | 61.143 | 25.180 | 16.247 |
| 1993M7 | 83.856 | 62.879 | 26.250 | 17.164 |
| 1993M8 | 84.088 | 64.592 | 24.750 | 17.747 |
| 1993M9 | 84.263 | 64.893 | 24.750 | 18.597 |
| 1993M10 | 84.611 | 66.301 | 25.250 | 19.427 |
| 1993M11 | 84.669 | 68.249 | 25.250 | 19.712 |
| 1993M12 | 84.669 | 76.805 | 26.460 | 18.734 |
| 1994M1 | 84.901 | 76.328 | 26.150 | 20.011 |
| 1994M2 | 85.192 | 79.343 | 23.810 | 21.378 |
| 1994M3 | 85.482 | 79.427 | 22.390 | 21.571 |

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|---|---|---|---|---|
| 1994M4 | 85.598 | 80.902 | 23.270 | 22.367 |
| 1994M5 | 85.656 | 82.683 | 23.040 | 23.064 |
| 1994M6 | 85.947 | 87.038 | 20.620 | 23.339 |
| 1994M7 | 86.179 | 89.460 | 22.630 | 24.075 |
| 1994M8 | 86.527 | 93.463 | 22.630 | 25.469 |
| 1994M9 | 86.760 | 95.452 | 22.760 | 25.728 |
| 1994M10 | 86.818 | 104.324 | 23.250 | 26.280 |
| 1994M11 | 86.934 | 107.965 | 23.000 | 27.884 |
| 1994M12 | 86.934 | 117.181 | 24.210 | 27.326 |
| 1995M1 | 87.282 | 122.878 | 25.100 | 29.162 |
| 1995M2 | 87.631 | 121.193 | 26.720 | 29.197 |
| 1995M3 | 87.921 | 122.134 | 27.960 | 29.356 |
| 1995M4 | 88.211 | 123.976 | 27.750 | 30.568 |
| 1995M5 | 88.386 | 126.999 | 27.750 | 32.595 |
| 1995M6 | 88.560 | 132.260 | 28.040 | 32.962 |
| 1995M7 | 88.560 | 131.773 | 28.040 | 33.708 |
| 1995M8 | 88.792 | 136.949 | 28.380 | 35.357 |
| 1995M9 | 88.966 | 140.526 | 28.380 | 36.321 |
| 1995M10 | 89.257 | 151.475 | 30.930 | 37.989 |
| 1995M11 | 89.199 | 160.481 | 32.860 | 38.068 |
| 1995M12 | 89.141 | 167.770 | 32.900 | 39.329 |
| 1996M1 | 89.663 | 171.199 | 33.870 | 42.072 |
| 1996M2 | 89.954 | 176.832 | 34.150 | 44.718 |
| 1996M3 | 90.418 | 181.933 | 34.150 | 45.212 |
| 1996M4 | 90.767 | 188.762 | 34.150 | 47.701 |
| 1996M5 | 90.941 | 191.716 | 34.250 | 48.960 |
| 1996M6 | 90.999 | 195.593 | 34.320 | 52.547 |
| 1996M7 | 91.173 | 202.627 | 34.320 | 54.661 |
| 1996M8 | 91.347 | 209.397 | 34.320 | 57.489 |
| 1996M9 | 91.638 | 210.743 | 34.320 | 60.270 |
| 1996M10 | 91.928 | 224.132 | 34.880 | 63.332 |
| 1996M11 | 92.102 | 232.184 | 35.620 | 67.196 |

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|---|---|---|---|---|
| 1996M12 | 92.102 | 233.533 | 35.620 | 68.090 |
| 1997M1 | 92.393 | 237.564 | 35.460 | 77.874 |
| 1997M2 | 92.683 | 245.360 | 35.680 | 79.236 |
| 1997M3 | 92.915 | 246.624 | 35.680 | 80.198 |
| 1997M4 | 93.031 | 252.112 | 35.680 | 82.656 |
| 1997M5 | 92.973 | 260.824 | 35.680 | 84.787 |
| 1997M6 | 93.089 | 269.763 | 35.680 | 92.371 |
| 1997M7 | 93.206 | 274.281 | 35.540 | 97.298 |
| 1997M8 | 93.380 | 279.155 | 35.710 | 98.335 |
| 1997M9 | 93.612 | 281.205 | 35.930 | 101.695 |
| 1997M10 | 93.844 | 293.523 | 35.930 | 103.847 |
| 1997M11 | 93.786 | 303.328 | 35.930 | 108.745 |
| 1997M12 | 93.670 | 336.491 | 36.210 | 115.661 |
| 1998M1 | 93.844 | 341.631 | 36.210 | 118.663 |
| 1998M2 | 94.019 | 338.259 | 32.000 | 118.228 |
| 1998M3 | 94.193 | 336.477 | 32.000 | 123.791 |
| 1998M4 | 94.367 | 344.118 | 32.000 | 126.725 |
| 1998M5 | 94.541 | 343.858 | 32.000 | 131.123 |
| 1998M6 | 94.657 | 354.184 | 32.880 | 138.677 |
| 1998M7 | 94.774 | 358.779 | 32.500 | 138.994 |
| 1998M8 | 94.890 | 357.901 | 32.500 | 144.058 |
| 1998M9 | 95.006 | 357.096 | 32.500 | 149.880 |
| 1998M10 | 95.238 | 371.374 | 31.000 | 156.414 |
| 1998M11 | 95.238 | 385.918 | 29.500 | 160.707 |
| 1998M12 | 95.180 | 395.341 | 29.500 | 159.187 |
| 1999M1 | 95.412 | 393.980 | 29.500 | 164.133 |
| 1999M2 | 95.529 | 387.046 | 29.500 | 165.561 |
| 1999M3 | 95.819 | 377.704 | 27.750 | 165.440 |
| 1999M4 | 96.516 | 388.115 | 27.750 | 178.206 |
| 1999M5 | 96.516 | 388.626 | 23.250 | 177.875 |
| 1999M6 | 96.516 | 399.424 | 23.250 | 191.650 |
| 1999M7 | 96.806 | 404.898 | 22.750 | 193.409 |

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|---|---|---|---|---|
| 1999M8 | 97.038 | 412.289 | 19.250 | 196.335 |
| 1999M9 | 97.503 | 405.751 | 19.250 | 206.688 |
| 1999M10 | 97.677 | 424.113 | 19.250 | 218.592 |
| 1999M11 | 97.735 | 446.036 | 20.750 | 240.886 |
| 1999M12 | 97.735 | 495.826 | 20.500 | 255.301 |
| 2000M1 | 98.026 | 484.413 | 23.000 | 252.458 |
| 2000M2 | 98.606 | 496.550 | 23.750 | 237.486 |
| 2000M3 | 99.419 | 514.492 | 23.750 | 244.600 |
| 2000M4 | 99.477 | 553.338 | 23.000 | 262.083 |
| 2000M5 | 99.594 | 584.018 | 25.000 | 283.693 |
| 2000M6 | 100.116 | 600.313 | 26.000 | 310.980 |
| 2000M7 | 100.348 | 582.769 | 31.250 | 301.630 |
| 2000M8 | 100.348 | 591.225 | 33.500 | 335.063 |
| 2000M9 | 100.871 | 603.596 | 33.500 | 360.119 |
| 2000M10 | 101.045 | 645.129 | 33.500 | 363.730 |
| 2000M11 | 101.103 | 726.772 | 33.500 | 376.247 |
| 2000M12 | 101.045 | 764.782 | 33.500 | 375.112 |
| 2001M1 | 101.684 | 757.530 | 33.500 | 371.878 |
| 2001M2 | 102.091 | 764.243 | 33.500 | 403.684 |
| 2001M3 | 102.323 | 729.657 | 33.500 | 393.909 |
| 2001M4 | 102.729 | 766.602 | 33.500 | 401.083 |
| 2001M5 | 103.194 | 755.433 | 33.500 | 410.510 |
| 2001M6 | 103.368 | 761.551 | 32.500 | 405.263 |
| 2001M7 | 103.078 | 782.552 | 32.500 | 423.587 |
| 2001M8 | 103.078 | 793.546 | 32.500 | 465.175 |
| 2001M9 | 103.542 | 848.277 | 31.500 | 402.998 |
| 2001M10 | 103.194 | 872.801 | 26.000 | 415.138 |
| 2001M11 | 103.020 | 953.543 | 24.500 | 441.698 |
| 2001M12 | 102.613 | 1007.140 | 23.250 | 446.050 |
| 2002M1 | 102.846 | 1036.070 | 22.500 | 443.698 |
| 2002M2 | 103.252 | 1049.470 | 16.000 | 457.947 |
| 2002M3 | 103.833 | 1057.970 | 16.000 | 467.428 |

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|---|---|---|---|---|
| 2002M4 | 104.413 | 1051.370 | 14.750 | 474.437 |
| 2002M5 | 104.413 | 1065.020 | 14.750 | 493.686 |
| 2002M6 | 104.472 | 1090.140 | 14.750 | 500.402 |
| 2002M7 | 104.588 | 1134.560 | 14.750 | 507.470 |
| 2002M8 | 104.936 | 1153.950 | 15.750 | 517.431 |
| 2002M9 | 105.110 | 1189.050 | 15.750 | 537.951 |
| 2002M10 | 105.285 | 1323.400 | 15.750 | 558.196 |
| 2002M11 | 105.285 | 1398.500 | 15.750 | 579.049 |
| 2002M12 | 105.052 | 1499.130 | 18.000 | 581.320 |
| 2003M1 | 105.517 | 1517.070 | 13.750 | 582.390 |
| 2003M2 | 106.330 | 1516.250 | 13.750 | 535.496 |
| 2003M3 | 106.969 | 1478.500 | 13.750 | 560.802 |
| 2003M4 | 106.736 | 1474.030 | 13.750 | 568.022 |
| 2003M5 | 106.562 | 1533.500 | 14.000 | 605.749 |
| 2003M6 | 106.678 | 1568.950 | 14.000 | 620.081 |
| 2003M7 | 106.794 | 1531.310 | 14.250 | 623.458 |
| 2003M8 | 107.201 | 1533.470 | 15.500 | 626.010 |
| 2003M9 | 107.549 | 1553.040 | 15.250 | 679.085 |
| 2003M10 | 107.433 | 1677.140 | 15.250 | 721.418 |
| 2003M11 | 107.143 | 1876.850 | 14.380 | 730.852 |
| 2003M12 | 107.027 | 2012.300 | 14.250 | 775.971 |
| 2004M1 | 107.549 | 2196.540 | 14.250 | 816.953 |
| 2004M2 | 108.130 | 1951.780 | 14.250 | 765.726 |
| 2004M3 | 108.827 | 1977.520 | 13.750 | 760.618 |
| 2004M4 | 109.175 | 1996.290 | 13.750 | 812.638 |
| 2004M5 | 109.814 | 2048.470 | 13.750 | 848.786 |
| 2004M6 | 110.163 | 2112.590 | 13.750 | 783.628 |
| 2004M7 | 109.988 | 2090.120 | 13.750 | 911.071 |
| 2004M8 | 110.046 | 2130.730 | 13.250 | 887.106 |
| 2004M9 | 110.279 | 2179.390 | 13.250 | 953.148 |
| 2004M10 | 110.859 | 2315.290 | 13.250 | 1037.210 |
| 2004M11 | 110.918 | 2438.320 | 13.250 | 1016.220 |

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|---|---|---|---|---|
| 2004M12 | 110.511 | 2564.470 | 13.250 | 1035.770 |
| 2005M1 | 110.743 | 2419.900 | 13.250 | 1037.350 |
| 2005M2 | 111.382 | 2416.730 | 10.500 | 1045.100 |
| 2005M3 | 112.253 | 2465.630 | 10.500 | 1071.420 |
| 2005M4 | 113.008 | 2550.870 | 10.500 | 1130.280 |
| 2005M5 | 112.892 | 2526.870 | 10.500 | 1182.030 |
| 2005M6 | 112.950 | 2538.960 | 10.500 | 1238.230 |
| 2005M7 | 113.473 | 2544.790 | 10.500 | 1284.280 |
| 2005M8 | 114.053 | 2605.430 | 10.500 | 1294.490 |
| 2005M9 | 115.447 | 2527.230 | 9.850 | 1330.730 |
| 2005M10 | 115.679 | 2691.760 | 9.850 | 1403.890 |
| 2005M11 | 114.750 | 2698.370 | 7.750 | 1427.200 |
| 2005M12 | 114.286 | 2804.180 | 7.750 | 1500.690 |
| 2006M1 | 115.157 | 2860.960 | 9.250 | 1407.490 |
| 2006M2 | 115.389 | 2913.960 | 9.250 | 1384.070 |
| 2006M3 | 116.028 | 2942.870 | 9.250 | 1429.500 |
| 2006M4 | 117.015 | 3048.540 | 9.250 | 1501.130 |
| 2006M5 | 117.596 | 3116.570 | 9.250 | 1596.140 |
| 2006M6 | 117.828 | 2699.790 | 9.250 | 1238.230 |
| 2006M7 | 118.177 | 2759.950 | 9.250 | 1284.280 |
| 2006M8 | 118.409 | 3350.150 | 9.250 | 1686.940 |
| 2006M9 | 117.828 | 3429.210 | 9.875 | 1803.770 |
| 2006M10 | 117.189 | 3536.350 | 7.500 | 1903.550 |
| 2006M11 | 117.015 | 3739.600 | 7.250 | 1964.130 |
| 2006M12 | 117.189 | 4004.930 | 8.000 | 2061.230 |
| 2007M1 | 117.547 | 4002.370 | 8.250 | 2089.760 |

**Data and Variables**

| Variables / Date | Real Effective Exchange Rate | M2 Money Plus Quasi Money (Billions of Cedis) | Consumer Price Index |
|---|---|---|---|
| 1992M1 | 162.530 | 366.266 | 12.285 |
| 1992M2 | 165.220 | 386.223 | 12.512 |
| 1992M3 | 166.570 | 396.004 | 12.790 |
| 1992M4 | 163.800 | 407.637 | 13.111 |
| 1992M5 | 161.980 | 403.858 | 13.304 |
| 1992M6 | 158.240 | 426.095 | 13.379 |
| 1992M7 | 152.690 | 437.010 | 13.581 |
| 1992M8 | 146.560 | 445.256 | 13.674 |
| 1992M9 | 141.480 | 457.855 | 13.576 |
| 1992M10 | 143.980 | 476.686 | 13.622 |
| 1992M11 | 148.960 | 527.311 | 13.788 |
| 1992M12 | 142.860 | 575.315 | 13.892 |
| 1993M1 | 148.830 | 610.408 | 14.921 |
| 1993M2 | 144.110 | 596.135 | 15.386 |
| 1993M3 | 139.050 | 597.207 | 15.767 |
| 1993M4 | 136.000 | 599.884 | 16.132 |
| 1993M5 | 138.090 | 594.280 | 16.488 |
| 1993M6 | 142.770 | 611.432 | 16.864 |
| 1993M7 | 135.690 | 628.787 | 17.001 |
| 1993M8 | 133.360 | 645.916 | 17.123 |
| 1993M9 | 130.530 | 648.931 | 17.225 |
| 1993M10 | 129.020 | 663.011 | 17.231 |
| 1993M11 | 128.370 | 682.486 | 17.458 |
| 1993M12 | 120.110 | 768.049 | 17.734 |
| 1994M1 | 116.950 | 763.280 | 18.325 |
| 1994M2 | 106.680 | 793.425 | 18.765 |
| 1994M3 | 106.080 | 794.273 | 19.162 |
| 1994M4 | 107.100 | 809.020 | 19.528 |

| | | | |
|---|---|---|---|
| 1994M5 | 107.230 | 826.826 | 19.949 |
| 1994M6 | 107.760 | 870.381 | 20.388 |
| 1994M7 | 106.170 | 894.600 | 20.796 |
| 1994M8 | 106.630 | 934.628 | 21.178 |
| 1994M9 | 109.640 | 954.519 | 21.721 |
| 1994M10 | 110.150 | 1043.240 | 22.304 |
| 1994M11 | 111.030 | 1079.650 | 22.992 |
| 1994M12 | 113.730 | 1171.810 | 23.795 |
| 1995M1 | 115.150 | 1228.780 | 24.845 |
| 1995M2 | 116.800 | 1211.930 | 25.968 |
| 1995M3 | 116.130 | 1221.340 | 27.514 |
| 1995M4 | 115.900 | 1239.760 | 29.279 |
| 1995M5 | 121.690 | 1269.990 | 31.144 |
| 1995M6 | 124.790 | 1322.600 | 32.998 |
| 1995M7 | 130.200 | 1317.730 | 34.771 |
| 1995M8 | 135.780 | 1369.490 | 35.990 |
| 1995M9 | 137.600 | 1405.260 | 36.883 |
| 1995M10 | 132.300 | 1514.750 | 37.725 |
| 1995M11 | 132.140 | 1604.810 | 39.141 |
| 1995M12 | 134.000 | 1677.700 | 40.646 |
| 1996M1 | 134.590 | 1711.990 | 42.037 |
| 1996M2 | 134.280 | 1768.320 | 43.635 |
| 1996M3 | 133.520 | 1819.330 | 45.340 |
| 1996M4 | 134.990 | 1887.620 | 46.924 |
| 1996M5 | 135.640 | 1917.160 | 48.037 |
| 1996M6 | 135.120 | 1955.930 | 48.976 |
| 1996M7 | 134.280 | 2026.270 | 49.599 |
| 1996M8 | 134.000 | 2093.970 | 50.103 |
| 1996M9 | 137.320 | 2107.430 | 50.350 |
| 1996M10 | 138.580 | 2241.320 | 50.661 |
| 1996M11 | 141.410 | 2321.840 | 52.124 |
| 1996M12 | 147.270 | 2335.330 | 53.921 |

| | | | |
|---|---|---|---|
| 1997M1 | 150.570 | 2375.640 | 55.282 |
| 1997M2 | 147.530 | 2453.600 | 56.969 |
| 1997M3 | 151.340 | 2466.240 | 58.587 |
| 1997M4 | 149.450 | 2521.120 | 60.574 |
| 1997M5 | 145.320 | 2608.240 | 62.243 |
| 1997M6 | 142.460 | 2697.630 | 63.202 |
| 1997M7 | 142.260 | 2742.810 | 64.067 |
| 1997M8 | 144.600 | 2791.550 | 64.241 |
| 1997M9 | 140.560 | 2812.050 | 61.993 |
| 1997M10 | 137.440 | 2935.230 | 61.286 |
| 1997M11 | 139.250 | 3033.280 | 61.708 |
| 1997M12 | 146.630 | 3364.910 | 62.613 |
| 1998M1 | 150.070 | 3416.310 | 63.828 |
| 1998M2 | 150.840 | 3382.590 | 65.694 |
| 1998M3 | 149.770 | 3364.770 | 67.913 |
| 1998M4 | 154.330 | 3441.180 | 71.850 |
| 1998M5 | 156.580 | 3438.580 | 73.759 |
| 1998M6 | 159.650 | 3541.840 | 74.231 |
| 1998M7 | 158.770 | 3587.790 | 73.301 |
| 1998M8 | 160.480 | 3579.010 | 73.418 |
| 1998M9 | 156.740 | 3570.960 | 72.768 |
| 1998M10 | 152.040 | 3713.740 | 71.788 |
| 1998M11 | 154.010 | 3859.180 | 71.683 |
| 1998M12 | 154.340 | 3953.410 | 72.476 |
| 1999M1 | 157.040 | 3939.800 | 73.611 |
| 1999M2 | 159.110 | 3870.460 | 75.576 |
| 1999M3 | 163.390 | 3777.040 | 77.243 |
| 1999M4 | 161.450 | 3881.150 | 79.202 |
| 1999M5 | 163.810 | 3886.260 | 80.690 |
| 1999M6 | 163.580 | 3994.240 | 81.843 |
| 1999M7 | 162.000 | 4048.980 | 82.600 |
| 1999M8 | 160.120 | 4122.890 | 82.234 |

| | | | |
|---|---|---|---|
| 1999M9 | 156.630 | 4057.510 | 81.341 |
| 1999M10 | 140.470 | 4241.130 | 80.845 |
| 1999M11 | 126.160 | 4460.360 | 80.864 |
| 1999M12 | 121.360 | 4958.260 | 82.469 |
| 2000M1 | 120.090 | 4844.130 | 84.125 |
| 2000M2 | 119.600 | 4965.500 | 86.865 |
| 2000M3 | 112.040 | 5144.920 | 89.270 |
| 2000M4 | 106.040 | 5533.380 | 93.070 |
| 2000M5 | 103.840 | 5840.180 | 95.798 |
| 2000M6 | 95.220 | 6003.130 | 98.085 |
| 2000M7 | 87.440 | 5827.690 | 100.826 |
| 2000M8 | 86.870 | 5912.250 | 104.111 |
| 2000M9 | 90.400 | 6035.960 | 107.614 |
| 2000M10 | 92.680 | 6451.290 | 111.067 |
| 2000M11 | 93.630 | 7267.720 | 113.268 |
| 2000M12 | 92.130 | 7647.820 | 115.902 |
| 2001M1 | 91.950 | 7575.300 | 118.549 |
| 2001M2 | 93.130 | 7642.430 | 121.730 |
| 2001M3 | 95.330 | 7296.570 | 126.714 |
| 2001M4 | 96.870 | 7666.020 | 129.826 |
| 2001M5 | 98.470 | 7554.330 | 132.126 |
| 2001M6 | 101.410 | 7615.510 | 134.215 |
| 2001M7 | 103.380 | 7825.520 | 136.007 |
| 2001M8 | 102.890 | 7935.460 | 137.451 |
| 2001M9 | 104.240 | 8482.770 | 138.077 |
| 2001M10 | 107.130 | 8728.010 | 139.503 |
| 2001M11 | 109.010 | 9535.430 | 140.086 |
| 2001M12 | 108.770 | 10071.400 | 140.582 |
| 2002M1 | 109.430 | 10360.700 | 142.101 |
| 2002M2 | 108.180 | 10494.700 | 144.041 |
| 2002M3 | 106.630 | 10579.700 | 147.017 |
| 2002M4 | 103.070 | 10513.700 | 149.155 |

| | | | |
|---|---|---|---|
| 2002M5 | 99.900 | 10650.200 | 151.071 |
| 2002M6 | 97.120 | 10901.400 | 152.577 |
| 2002M7 | 94.690 | 11345.600 | 154.350 |
| 2002M8 | 96.320 | 11539.500 | 155.497 |
| 2002M9 | 97.420 | 11890.500 | 155.857 |
| 2002M10 | 99.110 | 13234.000 | 157.909 |
| 2002M11 | 98.860 | 13985.000 | 159.682 |
| 2002M12 | 97.310 | 14991.300 | 161.907 |
| 2003M1 | 95.020 | 15170.700 | 165.193 |
| 2003M2 | 103.540 | 15162.500 | 186.333 |
| 2003M3 | 103.550 | 14785.000 | 190.939 |
| 2003M4 | 102.890 | 14740.300 | 193.840 |
| 2003M5 | 99.750 | 15335.000 | 196.109 |
| 2003M6 | 99.610 | 15689.500 | 197.665 |
| 2003M7 | 101.540 | 15313.100 | 199.103 |
| 2003M8 | 103.010 | 15334.700 | 198.527 |
| 2003M9 | 102.730 | 15530.400 | 197.553 |
| 2003M10 | 100.070 | 16771.400 | 196.685 |
| 2003M11 | 100.350 | 18768.500 | 197.628 |
| 2003M12 | 98.350 | 20123.000 | 200.052 |
| 2004M1 | 97.050 | 21965.400 | 202.209 |
| 2004M2 | 96.420 | 19517.800 | 207.354 |
| 2004M3 | 97.140 | 19775.200 | 211.024 |
| 2004M4 | 98.650 | 19962.900 | 215.513 |
| 2004M5 | 100.160 | 20484.700 | 218.123 |
| 2004M6 | 100.120 | 21125.900 | 221.284 |
| 2004M7 | 100.480 | 20901.200 | 223.727 |
| 2004M8 | 102.030 | 21307.300 | 224.111 |
| 2004M9 | 102.590 | 21793.900 | 222.413 |
| 2004M10 | 101.250 | 23152.900 | 221.160 |
| 2004M11 | 100.540 | 24383.200 | 221.935 |
| 2004M12 | 97.750 | 25644.700 | 223.615 |

| | | | |
|---|---|---|---|
| 2005M1 | 99.440 | 24199.000 | 225.673 |
| 2005M2 | 102.020 | 24167.300 | 236.448 |
| 2005M3 | 103.730 | 24656.300 | 246.274 |
| 2005M4 | 105.580 | 25508.700 | 251.208 |
| 2005M5 | 107.430 | 25268.700 | 253.744 |
| 2005M6 | 111.080 | 25389.600 | 256.131 |
| 2005M7 | 112.530 | 25447.900 | 256.968 |
| 2005M8 | 111.680 | 26054.300 | 257.228 |
| 2005M9 | 112.600 | 25272.300 | 255.728 |
| 2005M10 | 115.080 | 26917.600 | 255.325 |
| 2005M11 | 117.600 | 26983.700 | 255.907 |
| 2005M12 | 117.110 | 28041.800 | 256.794 |
| 2006M1 | 115.580 | 28609.600 | 258.517 |
| 2006M2 | 116.320 | 29139.600 | 264.940 |
| 2006M3 | 116.570 | 29428.700 | 270.581 |
| 2006M4 | 114.960 | 30485.400 | 274.964 |
| 2006M5 | 112.880 | 31165.700 | 279.651 |
| 2006M6 | 115.230 | 26997.900 | 283.042 |
| 2006M7 | 116.210 | 27599.500 | 286.259 |
| 2006M8 | 115.790 | 33501.500 | 285.980 |
| 2006M9 | 117.260 | 34292.100 | 283.420 |
| 2006M10 | 118.950 | 35363.500 | 282.186 |
| 2006M11 | 117.420 | 37396.000 | 282.316 |
| 2006M12 | 115.920 | 40049.300 | 283.835 |
| 2007M1 | 116.940 | 40023.700 | 286.346 |

**Data and Variables**

| Variables / Date | Crude Oil (US $ Per Barrel) | US Federal Fund Rate (Percent Per Annum) | Prime Rate (Percent Per Annum) |
|---|---|---|---|
| 1992M1 | 17.520 | 4.030 | 18.000 |
| 1992M2 | 17.650 | 4.060 | 18.000 |
| 1992M3 | 17.350 | 3.980 | 18.000 |
| 1992M4 | 18.650 | 3.730 | 18.000 |
| 1992M5 | 19.520 | 3.820 | 18.000 |
| 1992M6 | 20.880 | 3.760 | 18.000 |
| 1992M7 | 20.180 | 3.250 | 18.000 |
| 1992M8 | 19.620 | 3.300 | 18.470 |
| 1992M9 | 20.190 | 3.220 | 19.280 |
| 1992M10 | 20.040 | 3.100 | 20.380 |
| 1992M11 | 18.900 | 3.090 | 22.980 |
| 1992M12 | 17.930 | 2.920 | 25.410 |
| 1993M1 | 17.240 | 3.020 | 28.000 |
| 1993M2 | 18.230 | 3.030 | 28.000 |
| 1993M3 | 18.500 | 3.070 | 29.720 |
| 1993M4 | 18.440 | 2.960 | 29.720 |
| 1993M5 | 18.170 | 3.000 | 32.000 |
| 1993M6 | 17.370 | 3.040 | 32.000 |
| 1993M7 | 16.370 | 3.060 | 32.000 |
| 1993M8 | 16.430 | 3.030 | 32.000 |
| 1993M9 | 15.800 | 3.090 | 32.000 |
| 1993M10 | 16.440 | 2.990 | 32.000 |
| 1993M11 | 15.090 | 3.020 | 32.000 |
| 1993M12 | 13.360 | 2.960 | 32.000 |
| 1994M1 | 14.170 | 3.050 | 27.000 |
| 1994M2 | 13.750 | 3.250 | 27.000 |
| 1994M3 | 13.690 | 3.340 | 27.000 |
| 1994M4 | 15.150 | 3.560 | 27.000 |

| | | | |
|---|---|---|---|
| 1994M5 | 16.430 | 4.010 | 27.000 |
| 1994M6 | 17.230 | 4.250 | 27.000 |
| 1994M7 | 18.040 | 4.260 | 27.000 |
| 1994M8 | 16.980 | 4.470 | 27.000 |
| 1994M9 | 16.130 | 4.730 | 28.610 |
| 1994M10 | 16.480 | 4.760 | 28.990 |
| 1994M11 | 17.200 | 5.290 | 29.480 |
| 1994M12 | 16.130 | 5.450 | 29.500 |
| 1995M1 | 16.880 | 5.530 | 33.000 |
| 1995M2 | 17.440 | 5.920 | 33.000 |
| 1995M3 | 17.350 | 5.980 | 33.000 |
| 1995M4 | 18.770 | 6.050 | 33.000 |
| 1995M5 | 18.430 | 6.010 | 33.000 |
| 1995M6 | 17.330 | 6.000 | 33.000 |
| 1995M7 | 16.060 | 5.850 | 33.000 |
| 1995M8 | 16.490 | 5.740 | 33.000 |
| 1995M9 | 16.770 | 5.800 | 39.000 |
| 1995M10 | 16.180 | 5.760 | 40.500 |
| 1995M11 | 16.820 | 5.800 | 40.500 |
| 1995M12 | 17.930 | 5.600 | 40.500 |
| 1996M1 | 17.790 | 5.560 | 40.500 |
| 1996M2 | 17.690 | 5.220 | 40.500 |
| 1996M3 | 19.460 | 5.310 | 40.500 |
| 1996M4 | 20.780 | 5.220 | 41.000 |
| 1996M5 | 19.120 | 5.240 | 41.000 |
| 1996M6 | 18.560 | 5.270 | 41.460 |
| 1996M7 | 19.560 | 5.400 | 41.830 |
| 1996M8 | 20.190 | 5.220 | 42.160 |
| 1996M9 | 22.140 | 5.300 | 42.590 |
| 1996M10 | 23.430 | 5.240 | 42.650 |
| 1996M11 | 22.250 | 5.310 | 42.730 |
| 1996M12 | 23.510 | 5.290 | 42.760 |

| | | | |
|---|---|---|---|
| 1997M1 | 23.290 | 5.250 | 42.800 |
| 1997M2 | 20.540 | 5.190 | 42.800 |
| 1997M3 | 19.420 | 5.390 | 42.800 |
| 1997M4 | 17.980 | 5.510 | 42.800 |
| 1997M5 | 19.470 | 5.500 | 42.800 |
| 1997M6 | 18.020 | 5.560 | 42.800 |
| 1997M7 | 18.450 | 5.520 | 42.800 |
| 1997M8 | 18.790 | 5.540 | 42.800 |
| 1997M9 | 18.730 | 5.540 | 42.800 |
| 1997M10 | 20.120 | 5.500 | 42.800 |
| 1997M11 | 19.160 | 5.520 | 42.800 |
| 1997M12 | 17.240 | 5.500 | 42.480 |
| 1998M1 | 15.070 | 5.560 | 39.900 |
| 1998M2 | 14.180 | 5.510 | 39.500 |
| 1998M3 | 13.240 | 5.490 | 39.500 |
| 1998M4 | 13.390 | 5.450 | 39.500 |
| 1998M5 | 13.970 | 5.490 | 39.500 |
| 1998M6 | 12.480 | 5.560 | 35.240 |
| 1998M7 | 12.720 | 5.540 | 33.550 |
| 1998M8 | 12.490 | 5.550 | 33.500 |
| 1998M9 | 13.800 | 5.510 | 31.330 |
| 1998M10 | 13.260 | 5.070 | 26.810 |
| 1998M11 | 11.880 | 4.830 | 26.910 |
| 1998M12 | 10.410 | 4.680 | 26.750 |
| 1999M1 | 11.320 | 4.630 | 26.780 |
| 1999M2 | 10.750 | 4.760 | 25.810 |
| 1999M3 | 12.860 | 4.810 | 25.830 |
| 1999M4 | 15.730 | 4.740 | 25.700 |
| 1999M5 | 16.120 | 4.740 | 25.080 |
| 1999M6 | 16.240 | 4.760 | 24.450 |
| 1999M7 | 18.750 | 4.990 | 24.480 |
| 1999M8 | 20.210 | 5.070 | 24.500 |

| | | | |
|---|---|---|---|
| 1999M9 | 22.370 | 5.220 | 24.530 |
| 1999M10 | 22.190 | 5.200 | 26.560 |
| 1999M11 | 24.220 | 5.420 | 31.190 |
| 1999M12 | 25.010 | 5.300 | 31.490 |
| 2000M1 | 25.210 | 5.450 | 31.500 |
| 2000M2 | 27.150 | 5.730 | 31.500 |
| 2000M3 | 27.490 | 5.850 | 31.500 |
| 2000M4 | 23.450 | 6.020 | 31.520 |
| 2000M5 | 27.230 | 6.270 | 31.840 |
| 2000M6 | 29.620 | 6.530 | 36.770 |
| 2000M7 | 28.160 | 6.540 | 40.600 |
| 2000M8 | 29.410 | 6.500 | 40.110 |
| 2000M9 | 32.080 | 6.520 | 38.080 |
| 2000M10 | 31.400 | 6.510 | 37.910 |
| 2000M11 | 32.330 | 6.510 | 41.990 |
| 2000M12 | 25.280 | 6.400 | 41.990 |
| 2001M1 | 25.950 | 5.980 | 41.990 |
| 2001M2 | 27.240 | 5.490 | 41.990 |
| 2001M3 | 25.020 | 5.310 | 43.470 |
| 2001M4 | 25.660 | 4.800 | 45.000 |
| 2001M5 | 27.550 | 4.210 | 46.320 |
| 2001M6 | 26.970 | 3.970 | 46.680 |
| 2001M7 | 24.800 | 3.770 | 46.750 |
| 2001M8 | 25.810 | 3.650 | 42.910 |
| 2001M9 | 25.030 | 3.070 | 38.800 |
| 2001M10 | 20.730 | 2.490 | 34.830 |
| 2001M11 | 18.690 | 2.090 | 33.110 |
| 2001M12 | 18.520 | 1.820 | 29.700 |
| 2002M1 | 19.150 | 1.730 | 27.480 |
| 2002M2 | 19.980 | 1.740 | 27.000 |
| 2002M3 | 23.640 | 1.730 | 24.500 |
| 2002M4 | 25.430 | 1.750 | 24.500 |

| | | | |
|---|---|---|---|
| 2002M5 | 25.690 | 1.750 | 24.500 |
| 2002M6 | 24.490 | 1.750 | 24.500 |
| 2002M7 | 25.750 | 1.730 | 24.500 |
| 2002M8 | 26.780 | 1.740 | 24.500 |
| 2002M9 | 28.280 | 1.750 | 24.500 |
| 2002M10 | 27.530 | 1.750 | 24.500 |
| 2002M11 | 24.790 | 1.340 | 24.500 |
| 2002M12 | 27.890 | 1.240 | 24.500 |
| 2003M1 | 30.770 | 1.240 | 25.500 |
| 2003M2 | 32.880 | 1.260 | 25.500 |
| 2003M3 | 30.360 | 1.250 | 27.500 |
| 2003M4 | 25.490 | 1.260 | 27.500 |
| 2003M5 | 26.060 | 1.260 | 27.500 |
| 2003M6 | 27.910 | 1.220 | 27.500 |
| 2003M7 | 28.590 | 1.010 | 26.000 |
| 2003M8 | 29.680 | 1.030 | 26.000 |
| 2003M9 | 26.880 | 1.010 | 26.000 |
| 2003M10 | 29.010 | 1.010 | 24.000 |
| 2003M11 | 29.120 | 1.000 | 24.000 |
| 2003M12 | 29.950 | 0.980 | 21.500 |
| 2004M1 | 31.400 | 1.000 | 21.500 |
| 2004M2 | 31.320 | 1.010 | 20.000 |
| 2004M3 | 33.670 | 1.000 | 20.000 |
| 2004M4 | 33.710 | 1.010 | 20.000 |
| 2004M5 | 37.630 | 1.000 | 18.500 |
| 2004M6 | 35.540 | 1.030 | 18.500 |
| 2004M7 | 37.930 | 1.270 | 18.500 |
| 2004M8 | 42.080 | 1.430 | 18.500 |
| 2004M9 | 41.650 | 1.620 | 18.500 |
| 2004M10 | 46.870 | 1.750 | 18.500 |
| 2004M11 | 42.230 | 1.930 | 18.500 |
| 2004M12 | 39.090 | 2.160 | 18.500 |

| | | | |
|---|---|---|---|
| 2005M1 | 42.890 | 2.290 | 18.500 |
| 2005M2 | 44.560 | 2.500 | 18.500 |
| 2005M3 | 50.930 | 2.630 | 18.500 |
| 2005M4 | 50.640 | 2.780 | 18.500 |
| 2005M5 | 47.810 | 3.000 | 16.500 |
| 2005M6 | 53.890 | 3.040 | 16.500 |
| 2005M7 | 56.370 | 3.250 | 16.500 |
| 2005M8 | 61.870 | 3.490 | 16.500 |
| 2005M9 | 61.650 | 3.640 | 15.500 |
| 2005M10 | 58.190 | 3.760 | 15.500 |
| 2005M11 | 54.980 | 4.000 | 15.500 |
| 2005M12 | 56.470 | 4.160 | 15.500 |
| 2006M1 | 62.360 | 4.290 | 14.500 |
| 2006M2 | 59.710 | 4.490 | 14.500 |
| 2006M3 | 60.930 | 4.590 | 14.500 |
| 2006M4 | 68.000 | 4.770 | 14.500 |
| 2006M5 | 68.610 | 4.930 | 14.500 |
| 2006M6 | 68.290 | 5.000 | 14.500 |
| 2006M7 | 72.510 | 5.250 | 14.500 |
| 2006M8 | 71.810 | 5.250 | 14.500 |
| 2006M9 | 61.970 | 5.250 | 14.500 |
| 2006M10 | 57.950 | 5.250 | 14.500 |
| 2006M11 | 58.130 | 5.250 | 14.500 |
| 2006M12 | 61.000 | 5.240 | 12.500 |
| 2007M1 | 53.400 | 5.250 | 12.500 |

***The Empirical Model (Chapter 5)***

The conditional ECM estimated is shown as Equation (5.9).

$$\Delta \boldsymbol{i} = \mathbf{c_0} + \mathbf{b_1}\, \boldsymbol{i}_{t\text{-}1} + \Sigma^{k}_{j=1}\, \mathbf{d}_j\ \ \mathbf{X}_{j(t\text{-}1)} + \Sigma^{k}_{j=1}\, \Sigma^{p}_{m=0}\, \psi_{jm}\, \Delta \mathbf{X}_{j(t\text{-m})} + \Sigma^{p}_{m=1} \delta_m\, \Delta \boldsymbol{i}_{t\text{-}m\text{-}1} + \boldsymbol{u}_t \quad (5.9)$$

where $c_0 \neq 0$; $i_t$ is the policy interest rate, $X_{j(t-m)}$ the information vector, and $u_t$ serially uncorrelated errors. As previously elaborated, the model is valid whether the underlying regressors are purely I(1), I(0) or mutually cointegrated.

To ensure serially uncorrelated errors sufficiently long lags of the interest rate and information variables in differences are taken. At the same time, care is taken to balance this need with the need for a sufficiently small lag length to avoid undue over-parameterisation. In effect, the research follows Hendry's general-to-specific modelling approach and the AIC which is emphasised by PSS. The model specification allows for different lag lengths on the differenced variables without affecting the asymptotic results.

An important assumption underlying (5.9) is that there is no feedback from the level of $i_t$ to the equations explaining each of the information variables in the $X_{j(t-m)}$ vector stated in the previous section. Under the assumption that the lagged interest rate, $i_{t-1}$, does not enter the sub-VAR model for $X_{j(t-m)}$, the policy reaction function is identified and can be estimated by least squares. This assumption, however, does not rule out the inclusion of lagged changes of the interest rate in the equations for the variables in the information vector.

This empirical model enables us to work with the central bank policy instrument and its information variables in a way that allows the capturing of both short-run and long-run effects; and provides a link between the variables and the steady state equilibrium. The model says that a change in the policy interest rate depends on lagged changes of itself and in the information variables plus an error correction term, $[\mathbf{b_1}\, \boldsymbol{i}_{t\text{-}1} + \Sigma^{k}_{j=1}\, \mathbf{d}_j\ \ \mathbf{X}_{j(t\text{-}1)}]$**,** reflects reversion towards the equilibrium relationship. The speed of adjustment is given by the adjustment parameter, $b_1$.

The testing procedure for finding if a relationship exists between the policy interest rate and the information variables, i.e. if the information variables are the determinants of central bank interest rate setting, is a two-stage process. The first stage involves investigating the existence of a long-run (level) relationship between the policy interest rate and the information variable(s) by computing the F-statistic associated with the null hypothesis:

$H_0^{b1} : b_1 = 0 \;\cap\; H_0^{d}\, d' = 0'$

($d'$ being the vector of coefficients on the lagged-levels of the variables represented in the vector X);

against the alternative hypothesis:

$H_1^{b1} : b_1 \neq 0 \;\cup\; H_1^{d}\, d' \neq 0'$ .

The alternative hypothesis not only covers the case $b_1 \neq 0 \;\cup\; d' \neq 0'$, but also permits the cases of $b_1 = 0 \;\cup\; d' \neq 0'$ and $b_1 \neq 0 \;\cup\; d' = 0'$.

The asymptotic distribution of this test-statistic is non-standard, irrespective of whether the regressors are I(0) or I(1), thus PSS provide asymptotic critical values. Two polar sets of critical values are provided. One set assumes all the regressors are purely I(1) and the other that they are purely I(0). For each application the sets provide a band covering all possible classifications of the variables into I(0), I(1), or fractionally integrated.

If the computed statistic falls outside the *critical value bounds*, a conclusive inference can be drawn without needing to know the integration/cointegration status of the underlying regressors. However, if the F-statistic falls inside the bounds, inference is inconclusive and depends on whether the underlying variables are I(0) or I(1).

Comparing the *F*-statistic with the relevant critical value bounds, if the test statistic is less than the lower bounds, the null hypothesis is not rejected, signifying the absence of level relationship between the policy instrument and the information variable(s). In this case, the equation is re-estimated in pure differences. However, if the null hypothesis is rejected, we test a second null hypothesis:

$H_0^{b1}$ : $b_1 = 0$ using the bounds procedure based on t-statistic $t_{b1}$.

As with the *F*-test, asymptotic critical value bounds of this test are provided for cases in which all regressors are purely I(1), purely I(0), or mutually co integrated. Rejection of $H_0^{b1}$ : $b_1 = 0$ confirms the existence of a level relationship. On the other hand if $H_0^{b1}$ is not rejected, it implies that though a level relationship between the policy interest rate and the regressor set exits, the speed of convergence of the variables to equilibrium is so slow as not to be significantly different from zero. The second stage of the analysis is, then, to estimate the long-run interest rate responses to the information variables and make inferences about the size of coefficients. The long-run coefficients are derived by assuming that all variables are constant in equilibrium, so that Equation (5.9) reduces to:

$$0 = \mathbf{c_0} + \mathbf{b_1}\, \boldsymbol{i} + \boldsymbol{\Sigma}^{k}_{j=1}\, \mathbf{d}_j\ \mathbf{X}_j + \boldsymbol{u} \qquad (5.10)$$

The constant and level regressors then have their long-run parameters given by:

$w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$

where $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model. Therefore equation (5.10) can be re-arranged as:

$$\boldsymbol{i} = \boldsymbol{w_0} + \boldsymbol{w_j}\, \boldsymbol{\Sigma}^{k}_{j=1}\, \mathbf{X}_j + \boldsymbol{u} \qquad (5.11)$$

The long-run inflation and output gap coefficients are respectively compared with the reference values of 1.5 and 0.5 proposed by Taylor (1993), to assess the extent to which monetary policy is effective in stabilising inflationary conditions. In addition, a view is formed on whether long-run interest rate responses to the other variables are appropriately-signed and sizeable enough to facilitate the attainment of the inflation objective.

***The Empirical Model (Chapter 6)***

The research uses the *modified* single equation cointegration and error correction estimation method developed by Pesaran *et al.* (2001), a summary of which is provided in sub-Section 5.2.1 of Chapter 5 to quantify the short-run and long-run responses of commercial bank retail rates to the policy interest rate, and investigate asymmetries in pass-through when the policy rate increases compared to when it decreases, Specifically, we estimate equation (6.1) below:

$$\Delta TMTDR_t = c_0 + c_1 TMTDR_{t-1} + c_2 PR_{t-1} + \sum_{m=1}^{p} c_{3m}\Delta TMTDR_{t-m} + \sum_{m=0}^{p} c_4 \Delta PR_{t-m} + u_t \quad \ldots \quad (6.1)$$

The dependent variable is the change in commercial bank retail rate, $\Delta TMTDR$; and $PR_t$ is the central bank policy interest rate. As discussed in Section 5.2.1, this representation of the error correction model is superior to the traditional models of its kind as it is robust to the stationarity conditions of the data: it is valid whether the data are I(1) or I(0).

The statistic underlying the Pesaran *et al*. (2001) procedure is the *F*-statistic in a generalised Dickey-Fuller type regression. Pesaran *et al*. (2001) provide two sets of asymptotic critical values for the two polar cases - one, that all regressors are purely I(1); and two, that they are purely I(0). The two sets of asymptotic critical values provide a band covering all possible classifications of the regressors. If the *F*-statistic falls inside these bounds, inference is inconclusive and knowledge of the order of integration of the underlying variables is required before conclusive inference is made. However, if the computed *F*-statistic falls outside the *critical value bounds*, a conclusive inference can be drawn without needing to know the integration status of the underlying regressors. Where a relationship in levels is found, a related bounds test based on the $t$-statistic associated with the coefficient on the lagged-level dependent variable is conducted, to confirm the existence of the levels relationship.

Serially uncorrelated errors ($u_t$) are ensured by including sufficiently long lags of changes in the interest rates. The problem of over-parameterising is avoided by following the general-to-specific modelling strategy, and in particular the AIC that is emphasised by PSS. Having estimated equation (6.1), the test for a relationship in levels between $TMTDR_t$ and $PR_t$ is by the $F$-test for the joint significance of the lagged-level variables, where the null hypothesis is $H_0^{c1} : c_1 = 0 \cap H_0^{c2}\ c_2 = 0$;

and the alternative hypothesis is $H_1^{c1} : c_1 \neq 0 \cup H_1^{c2}\ c_2 \neq 0$.

If the null hypothesis is not rejected, it implies an absence of levels or long-run relationship between the lending rate and the policy interest rate, and a specification in first differences is estimated to prevent the risk of spurious regression. If the null hypothesis is rejected, we test the null hypothesis $H_0^{c1} : c_1 = 0$ using the bounds procedure based on the $t$-statistic $t_{c1}$. If $H_0^{c1} : c_1 = 0$ is rejected, a large value of the statistic testing the null will result, confirming the existence of a levels relationship. On the other-hand if the null is not rejected, it implies that although a levels relationship between the lending rate and the policy interest rate exists, the speed of convergence of the variables to equilibrium is so slow as not to be significantly different from zero. We derive the long–run coefficients by assuming that all variables are constant in equilibrium, so that Equation (6.1) reduces to:

$$0 = c_0 + c_1\, TMTDR + c_1\, PR \qquad (6.2)$$

which can be re-arranged as:

$$TMTDR = w_0 + w_2 PR \qquad (6.3)$$

The long-run constant, $w_0$, and the long-run coefficient on the policy interest rate, $w_2$, are given by:

$w_0 = - c_0/c_1$ and $w_2 = - c_2/c_1$

where, $c_0$ is the constant term, $c_1$ is the coefficient on the lagged-level retail rates, and $c_2$ the coefficient associated with the policy interest rate in levels in the short-run model. The long-run constant, $w_0$, reflects the mark-up on the policy interest rate, and $w_2$ reflects the long-run pass through of the policy interest rate. Under competitive market conditions and assuming a credit risk premium, the commercial bank retail rate is expected to move one-for-one with the policy interest rate (Borio and Fritz, 1995). That is, $w_2$ is expected to equal one.

Inferences on short-run behaviour are made from coefficients on the terms in differences. The coefficient $c_{40}$ reflects the immediate pass-through of changes in the policy rate; $c_{41}$, the pass-through after one month, etc. Short-run behaviour is also inferred from the coefficient on the lagged-level lending rate. This statistic gives the extent of error correction in one month.

**Exogenous Test (Table IX)**

| | |
|---|---|
| Chapter 5 (Strict Inflation Targeting) | |
| Lagrange Multiplier Statistic | CHSQ( 1)= 23.1196[0.000] |
| Likelihood Ratio Statistic | CHSQ( 1)= 24.7353[0.000] |
| F Statistic | F( 1, 176)= **25.7730[0.000]** |
| F Critical @ 95 per cent = **3.84** | |
| Chapter 5 (Strict Inflation Targeting) | |
| Lagrange Multiplier Statistic | CHSQ( 2)= 24.2886[0.000] |
| Likelihood Ratio Statistic | CHSQ( 2)= 26.0805[0.000] |
| F Statistic | F( 2, 173)= **13.4066[0.000]** |
| F Critical @ 95 per cent = **3.00** | |
| Chapter 6 | |
| Lagrange Multiplier Statistic | CHSQ( 1)= 19.4004[0.000] |
| Likelihood Ratio Statistic | CHSQ( 1)= 20.5210[0.000] |
| F Statistic | F( 1, 176)= **21.1292[0.000]** |
| F Critical @ 95 per cent = **3.84** | |
| **The null hypothesis of endogeneity is rejected in all three tests.** | |

## Alternative Model (McCallum, 1995a)

**Table XA**

Dependent variable is change in money stock

Sample from 1992M1 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| C | 24.7605 | 6.4762 | 3.8233[0.000] |
| ANF1M | -0.99393 | 0.16015 | -6.2061[0.000] |
| ANRMO21M(-1) | -1.0070 | 0.058348 | -17.2583[0.000] |
| ANRMO21M(-9) | -.17018 | 0.066344 | -2.5650[0.011] |
| ANRMO21M(-11) | 0.18908 | 0.069392 | 2.7248[0.007] |
| ANRMO21M(-12) | 0.23766 | 0.072736 | 3.2674[0.001] |
| ANF1M(-11) | 0.65132 | 0.19761 | 3.2960[0.001] |
| ANF1M(-12) | -0.47888 | 0.20695 | -2.3140[0.022] |

| | | | |
|---|---|---|---|
| R-Squared | 0.65529 | R-Bar-Squared | 0.64135 |
| S.E. of Regression | 39.4055 | F-stat. F( 7, 173) | 46.9823[0.000] |

Diagnostic Tests

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ( 12)= 14.7249[0.257] | F( 12, 161)= 1.1881[0.296] |
| Functional Form | CHSQ( 1)= 2.4239[0.119] | F( 1, 172)= 2.3346[0.128] |
| Normality | CHSQ( 2)= 466.6275[0.000] | Not applicable |
| Heteroscedasticity | CHSQ( 1)= 0.054260[0.816] | F( 1, 179)= 0.053676[0.817] |

Note:

| | |
|---|---|
| ANRMO21M | : The deseasonalised one-month annualised Money stock |
| ANF1M | : The deseasonalised one-month annualised inflation |

Variables preceded by D are the one month differences of the respective variable in levels.

Inflation in levels is significant and correctly-signed. Testing for the existence of a relationship in levels between the money stock and inflation with a constant as the only deterministic variable in the model gives an *F*-statistic of 46.98. The high *F*-statistic implies a conclusive inference can be drawn without needing to know the integration/cointegration status of the regressors. It indicates the existence of a long-term (levels) relationship between the money stock and inflation. The *t*-ratio of the lag of money stock confirms a level relationship.

The long–run coefficients are derived by assuming that all variables are constant in equilibrium and given by (Pearson, Shin and Smith, 2001).

$$\boldsymbol{i = w_0 + w_j \Sigma^k_{j=1} \mathrm{X}_j + u} \qquad (5.11)$$

where, $w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$, $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model.

Substituting into the above equation with standard error in parentheses gives:

$$\text{ANRMO21M} = -24.558 + \underset{(0.198)}{0.816}\ \text{ANF1M}$$

**Table XB**

Dependent variable is change in money stock

Sample from 2002M3 to 2007M1

| Regressor | Coefficient | Standard Error | T-Ratio[Prob] |
|---|---|---|---|
| C | 50.0518 | 9.7502 | 5.1334[0.000] |
| ANF1M | -1.2455 | 0.35532 | -3.5053[0.001] |
| ANRMO21M(-1) | -0.96194 | 0.11249 | -8.5516[0.000] |
| ANRMO21M(-9) | -0.30309 | 0.13356 | -2.2694[0.027] |
| ANF1M(-12) | -1.0330 | 0.34176 | -3.0226[0.004] |
| R-Squared | 0.62477 | R-Bar-Squared | 0.59698 |
| S.E. of Regression | 52.1575 | F-stat. F( 4, 54) | 22.4780[0.000] |

Diagnostic Tests

| Test Statistics | LM Version | F Version |
|---|---|---|
| Serial Correlation | CHSQ( 12)= 5.9008[0.921] | F( 12, 42)= 0.38894[0.960] |
| Functional Form | CHSQ( 1)= 0.27626[0.599] | F( 1, 53)= 0.24933[0.620] |
| Normality | CHSQ( 2)= 127.1050[0.000] | Not applicable |
| Heteroscedasticity | CHSQ( 1)= 0.45599[0.500] | F( 1, 57)= 0.44397[0.508] |

Note:

ANRMO21M : The deseasonalised one-month annualised Money stock

ANF1M : The deseasonalised one-month annualised inflation

Variables preceded by D are the one month differences of the respective variable in levels.

Inflation in levels is significant and correctly-signed. Testing for the existence of a relationship in levels between the money stock and inflation with a constant as the only deterministic variable in the model gives an *F*-statistic of 22.48. The high *F*-statistic implies a conclusive inference can be drawn without needing to know the integration/cointegration status of the regressors. It indicates the existence of a long-term (levels) relationship between the money stock and inflation. The *t*-ratio of the lag of money stock confirms a level relationship.

The long–run coefficients are derived by assuming that all variables are constant in equilibrium and given by (Pearson, Shin and Smith, 2001).

$$\boldsymbol{i = w_0 + w_j \Sigma^k_{j=1} X_j + u} \qquad (5.11)$$

where, $w_o = c_o / \hat{b}_1$ and $w_j = \hat{d}_j / \hat{b}_1$, $b_1$ is the coefficient on the lagged-level dependent variable, $c_o$ is the constant term, and $d_j$ the coefficient associated with the $j^{th}$ lagged-level regressor in the short-run model.

Substituting into the above equation with standard error in parentheses gives:

$$\text{ANRMO21M} = -52.032 + \underset{(0.342)}{1.074}\ \text{ANF1M}$$