A Suicidal Kuznets Curve?

Nikolaos Antonakakis[*†] Alan Collins[‡]

February 9, 2018

Abstract

Suicide rates from a global sample of 73 countries over the period 1990-2010 are empirically explored. We find evidence of an 'N-shaped' suicidal Kuznets curve between per capita income and suicide rates in the male population of 25-34, 34-54 and 55-74 age groups and the female population of the 55-74 age group. These results remain firm to several robustness checks.

Key words: Suicide; GDP growth; Kuznets curve; Unemployment; Fertility; Life expectancy

JEL codes: C33, E32, I15, I31, J13

[*]Corresponding author: Webster Vienna University, Department of Business and Management, Praterstrasse 23, 1020, Vienna, Austria tel: +43 1 269 9293 4354, e-mail: nikolaos.antonakakis@webster.ac.at.

[†]University of Portsmouth, Economics and Finance Subject Group, Portsmouth Business School, Portland Street, Portsmouth, PO1 3DE, United Kingdom Tel: +44 (0)23 9284 4261, fax: +44 (0)23 9284 4037, e-mail: nikolaos.antonakakis@port.ac.uk

[‡]Nottingham Trent University, Department of Economics, Nottingham Business School, 50 Shakespeare Street, NG1 4FQ, Nottingham, United Kingdom, e-mail: alan.collins@ntu.ac.uk.

1 Introduction

Suicide rates are an indicator of extreme life dissatisfaction and constitute a negative revealed preference indicator of well-being within a given country. This remains contentious given some medical researchers caution against inferring broader societal mental health conditions from suicide rates (Holley, 1998). However, if the focus is on inferring more narrowly across suicidal ideation and chronic depression, then such inference is reasonable.

The well-being and specifically mental health effects of variations in socioeconomic factors have received enormous empirical attention. One particular aspect, the linkage between suicide mortality and unemployment, has prompted much discussion in recent decades (see, for example, Antonakakis and Collins, 2014, 2015) and there is a sizeable literature on the link to other socioeconomic indicators, such as income and/or economic growth (see, for example, Hamermesh and Soss, 1974; Virén, 1999; Jungeilges and Kirchgassner, 2002; Andrés, 2005; Okada and Samreth, 2013). Despite the breadth and depth of existing work, no study to our best knowledge examines in a systematic fashion the global pattern of well-being via a revealed preference approach and with a particular focus on the suicide-income (growth) relationship.

Economic prosperity has been postulated in various works to lead to both declines and rises in suicide mortality.This is reflected by mixed evidence in empirical work. For example, Virén (1999) and Jungeilges and Kirchgassner (2002) suggest that suicide rates have a positive association with income while there are many others suggesting the opposite effect (e.g. Andrés et al., 2011; Okada and Samreth, 2013) or insignificant results. Against this backdrop, we examine whether suicide mortality differs with respect to socio-demographic factors and the level of economic development among countries. Put differently, we investigate the existence or otherwise of a 'suicidal Kuznets curve' (SKC). We find evidence of an N-shaped suicidal Kuznets curve between per capita income and suicide rates in the male population of 25-34, 34-54 and 55-74 age groups and the female population of the 55-74 age group.

The remainder of this paper is organised as follows. Section 2, outlines the methodology and describes the data used. Section 3 presents the empirical results and Section 4 summarises and offers some concluding remarks.

2 Data and Methodology

Annual observations of gender- and age-specific suicide and population data were extracted from the World Health Organization (WHO) Mortality Database. Missing values of suicide and population were supplemented (where possible) with data from the official national statistics agency of each country and United Nations statistics. Following inspection of the data series we settled on a panel dataset of 73 countries covering the period 1990 to 2010. The choice of specific countries and time periods was driven by data availability. For a detailed data description, please refer to the Online Appendix.

Following earlier literature (see Chen et al., 2012), we additionally control for the potential socioeconomic determinants of suicide rates across countries. We estimated variants of the following (extended) Suicidal Kuznets curve model:

$$S_{ijkt} = \alpha_0 + \alpha_1 S_{ijkt-1} + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Y_{it}^3 + \beta_4 E_{it} + \beta_5 D_{it} + \gamma_i + \delta_t + \varepsilon_{it} \qquad (1)$$

where S_{ijkt} is the suicide rate in country i (where i = 1, 2, ..., 73), population j (where j = overall, male, female), age group k (where k = all, 15-24, 25-34, 35-54, 55-74, 75+ years) and time t (where t = 1990,...,2010); α_0 is a constant; S_{ijkt-1} is the first lag of S_{ijkt} and is included to account for dynamic effects and to filter autocorrelation of order one, AR(1), found in the series; Y_{it}, Y_{it}^2 and Y_{it}^3 denote the logarithm of real per capita GDP (at purchasing power parity, PPP, rates; 2011 US$) in level, square and cubic terms, respectively; E_{it} is a vector of economic characteristics affecting suicide rates, such as the growth rate of real GDP, $Growth_{it}$, and the unemployment rate, $Unemp_{ijt}$; D_{it} is a vector of demographic and social characteristics affecting suicide rates, such as fertility rate, $Fert_{it}$, life expectancy, $Lifexp_{ijt}$ and the share of urban population, $Urban_{it}$. γ_{1i} are country fixed–effects controlling for time–invariant country characteristics, and δ_t are time fixed–effects, controlling for any time–varying differences in the dependent variable common to all countries, such as the global financial crisis. ε_{it} is the error term.

However, the inclusion of the lagged dependent variable, S_{ijkt} gives rise to 'dynamic panel bias', and any potential endogeneity of the right hand side variables, may give rise to inconsistent estimates under the fixed effects (FE) estimator. To overcome these issues, we employ the system generalised method of moments (System–GMM) estimator approach.

Moreover, we used the two-step rather than the one-step approach, as the former is asymptotically more ecient than the latter and is robust to substantial heteroskedasticity and autocorrelation within panels. The inclusion of the logarithm of per capita GDP in level, Y_t, square, Y_t^2, and cubic, Y_t^3, terms in model (1) serves as our primary focus in the examination of the potential relationship between suicide rates and economic development, i.e. the SKC. The existence and shape of such a curve depends on the significance and signs of the coefficients β_1, β_2 and β_3 from model (1).

3 Estimation Results

The main results of our empirical analysis for male and female populations, across the various age groups, are reported in Tables 1 to 2.[1] There is evidence of gender– and age–specificity in the relationship between suicide rates and economic development. We observe that, generally, the coefficients of per capita income, including squared and cubic counterparts are positive, negative and positive, respectively, across males of all ages in Table 1. Yet, they are only significant for the 25–34 (at the 10% level), 35–54 (at the 5% level) and 55–74 (at the 10% level) age groups, under columns (3), (4) and (5) of Table 1, respectively. This is suggestive of the existence of an N-shaped Suicidal Kuznets curve in the case of the aforementioned age groups of the male population. Further, the validity of our instruments is strongly supported, as the autocorrelation tests of order 1 and 2 in the first-differenced residuals of the GMM approach point to first–order but not second–order autocorrelation, as one would expect. Turning to the female population results reported in Table 2, an N-shaped SKC is identified for females in the 55–74 age group under column (5) of Table 2. Further our model appears correctly specified, as the results of the autocorrelation tests provide strong support to the validity of our instruments.

[Insert Tables 1 and 2 around here]

The N-shaped SKCs empirically identified are in line with an assessment of the corresponding scatter plots (not presented herein, but available from authors upon request). Further, our empirical results suggest that a significant N-shaped SKC exists only for

[1] The results for the overall population are available in the Online Appendix.

the female population in the 55-74 age group. The results for the remaining predictors of suicide mortality accounted for are in line with the existing literature and are significant in many instances. Yet, there is also evidence of gender- and age- heterogeneity in the responses of suicides rates to those predictors.

Having found evidence of an N-shaped SKC for the identified age groups we calculated the inflection points (for calculation details, please refer to the Online Appendix). The inflection points are presented in Table 3. For the male population of 25-34, 34-54 and 55-74 age groups these are \$7,727 and \$46,306, \$5,266 and \$22,726, and \$3,459 and \$53,260, respectively, while for the female population of 5574 age groups are \$4,022 and \$43,351. On average and across both genders, as per capita income increases, suicide rates for the 25-34 and 35-54 age groups follow an increasing trend and peak when per capita income reaches \$7,304 and \$6,498, respectively, then follow a declining trend until \$60,819 and \$25,129, respectively, and increase thereafter again.

[Insert Table 3 around here]

Finally, the aforementioned results are very robust to various robustness checks presented in the Online Appendix.

4 Summary and Concluding Discussion

Intuitively it appears from these results that the race to increase income over time in order to escape poverty generates net negative mental health spillover effects. Then for middle-income countries, any further income rises are seemingly associated with net positive mental health spillover effects. For high-income group countries, further income increases seem to be associated again with net negative mental health spillover effects. It seems likely, however, that there are a different or wider range of factors (compared to the low-income countries) that account for these net negative mental health spillover effects which further research might help identify e.g. work-life balance concerns, arduous commuting, peer group pressures and status anxieties that echo elements of the Duesenberry (1949) relative income hypothesis.

Exploring the link between economic development and well-being via this revealed preference methodology has uncovered some robust evidence of SKCs. Controlling for several country–specific suicide determinants, we show evidence of an N-shaped SKC both in the male population (within the 25–34, 34–54 and 55-74 age groups) and female population (in the 55–74 age group).

These results goes some way to account for the degree of plurality in the existing body of empirical findings on the suicide-economic growth linkage. The results may also serve as evidence to prompt some countries, in the face of declining suicide rates, to guard against complacency if increased economic prosperity is anticipated. Given the N-shaped form of the relationship there is a case for resisting very significant diminution of resources devoted to encouraging mental health wellbeing and addressing suicidal behaviour.

References

Andrés, A. R., 2005. Income Inequality, Unemployment, and Suicide: A Panel Data Analysis of 15 European Countries. *Applied Economics* 37 (4), 439–451.

Andrés, A. R., Halicioglu, F., Yamamura, E., 2011. Socio-economic Determinants of Suicide in Japan. *Journal of Behavioral and Experimental Economics* 40 (6), 723–731.

Antonakakis, N., Collins, A., 2014. The Impact of Fiscal Austerity on Suicide: On the Empirics of a Modern Greek Tragedy. *Social Science & Medicine* 112, 39–50.

Antonakakis, N., Collins, A., 2015. The Impact of Fiscal Austerity on Suicide Mortality: Evidence Across the Eurozone 'Periphery'. *Social Science & Medicine* 145, 63–78.

Bond, S. R., 2002. Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice. *Portuguese Economic Journal* 1 (2), 141–162.

Brainerd, E., 2001. Economic Reform and Mortality in the Former Soviet Union: A Study of the Suicide Epidemic in the 1990s. *European Economic Review* 45 (4–6), 1007–1019.

Chen, J., Choi, Y. J., Mori, K., Sawada, Y., Sugano, S., 2012. Socio-Economic Studies On Suicide: A Survey. *Journal of Economic Surveys* 26 (2), 271–306.

Duesenberry, J. S., 1949. *Income, Saving and the Theory of Consumer Behaviour*. Cambridge, MA: Harvard University Press.

Hamermesh, D. S., Soss, N. M., 1974. An Economic Theory of Suicide. *Journal of Political Economy* 82 (1), 83–98.

Holley, H., 1998. Geography and Mental Health: A Review. *Social Psychiatry and Psychiatric Epidemiology* 33 (11), 535–542.

Jungeilges, J., Kirchgassner, G., 2002. Economic Welfare, Civil Liberty, and Suicide: An Empirical Investigation. *Journal of Socio-Economics* 31 (3), 215–231.

Nickell, S. J., 1981. Biases in Dynamic Models with Fixed Effects. *Econometrica* 49 (6), 1417–1426.

Okada, K., Samreth, S., 2013. A study on the Socio-economic Determinants of Suicide: Evidence from 13 European OECD Countries. *Journal of Behavioral and Experimental Economics* 45 (C), 78–85.

Virén, M., 1999. Testing the "Natural Rate of Suicide" Hypothesis. *International Journal of Social Economics* 26 (12), 1428–1440.

Table 1: N-shaped Suicidal Kuznets Curve? Male population

	(1)	(2)	(3)	(4)	(5)	(6)
	all	15-24	25-34	35-54	55-74	75+
Lagged Dep. Var.	0.9853***	0.4552***	0.4725***	0.9074***	0.7232***	0.4893***
	(0.0351)	(0.0780)	(0.1320)	(0.0414)	(0.0924)	(0.0935)
Per Capita Income	61.5332	10.4950	277.9982*	246.8616**	232.6048*	-190.9893
	(40.9405)	(75.1504)	(153.0956)	(119.1554)	(137.3880)	(283.0908)
Per Capita Income^2	-6.8394	-0.3670	-28.4649*	-26.7090**	-24.9591*	23.0303
	(4.3601)	(8.1897)	(16.2027)	(12.6851)	(14.6648)	(31.2001)
Per Capita Income^3	0.2520*	-0.0081	0.9635*	0.9573**	0.8743*	-0.8903
	(0.1531)	(0.2959)	(0.5698)	(0.4451)	(0.5168)	(1.1341)
Growth	-8.2030**	-2.4913	-7.7748	-17.1962**	-13.0094*	-6.3905
	(3.2233)	(1.6648)	(5.2864)	(7.6698)	(6.9517)	(6.8996)
Unemployment	0.0267	0.1349**	0.2054**	0.0079	0.0509	0.0669
	(0.0390)	(0.0645)	(0.0961)	(0.0839)	(0.0871)	(0.1462)
Fertility	-0.9209**	-2.9390***	-2.9054**	-1.9080***	-2.8069*	-2.8918
	(0.4328)	(0.8679)	(1.4062)	(0.7194)	(1.4729)	(3.1257)
Life Expectancy	-0.1310	-0.5338***	-1.0843***	-0.3375	-0.2696	-0.1016
	(0.1215)	(0.1742)	(0.3866)	(0.2434)	(0.3793)	(0.4848)
Urban Population	-0.0012	0.1446	0.1344	0.2057*	0.0661	0.4788**
	(0.0340)	(0.1107)	(0.1309)	(0.1110)	(0.1292)	(0.1896)
Country-Fixed-Effects	YES	YES	YES	YES	YES	YES
Time-Fixed-Effects	YES	YES	YES	YES	YES	YES
Observations	1,411	1,411	1,411	1,411	1,411	1,411
Number of countries	73	73	73	73	73	73
χ^2	38506***	1078***	1410***	10452***	3353***	825.3***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(1)	-4.678***	-3.456***	-2.616***	-3.501***	-2.740***	-1.506***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(2)	1.247	0.397	0.989	0.776	0.752	0.0439
	[0.21]	[0.69]	[0.32]	[0.44]	[0.45]	[0.96]

Note: See notes of Table A.5.

Table 2: N-shaped Suicidal Kuznets Curve? Female population

	(1)	(2)	(3)	(4)	(5)	(6)
	all	15-24	25-34	35-54	55-74	75+
Lagged Dep. Var.	0.8241***	0.4978***	0.2437**	0.6066***	0.5719***	0.6030***
	(0.0427)	(0.0421)	(0.0980)	(0.0554)	(0.0875)	(0.0820)
Per Capita Income	23.8123	39.0247	-1.7890	58.9856	120.0029**	-111.9262
	(16.8466)	(38.4215)	(66.1227)	(39.8600)	(60.2928)	(136.4606)
Per Capita Income^2	-2.4911	-4.2019	0.5390	-6.0478	-12.8491**	12.0443
	(1.7562)	(4.1969)	(7.0366)	(4.2406)	(6.4391)	(14.6911)
Per Capita Income^3	0.0871	0.1508	-0.0344	0.2041	0.4514**	-0.4337
	(0.0607)	(0.1513)	(0.2474)	(0.1499)	(0.2273)	(0.5265)
Growth	-1.6838*	-3.1782***	-0.5218	-1.7867*	-2.1579	-2.4504
	(0.8838)	(1.1305)	(1.2468)	(1.0380)	(2.3221)	(2.9392)
Unemployment	0.0087	0.0370	0.0134	0.0098	-0.0067	-0.0247
	(0.0085)	(0.0357)	(0.0272)	(0.0225)	(0.0259)	(0.0548)
Fertility	-0.4405**	-0.7270	-0.1711	-0.4285	-0.9797**	-1.5068
	(0.1948)	(0.4687)	(0.4581)	(0.3246)	(0.4110)	(1.1314)
Life Expectancy	-0.0158	-0.2085	0.0972	0.0237	-0.0459	0.0567
	(0.0360)	(0.1401)	(0.1812)	(0.0676)	(0.0874)	(0.2430)
Urban Population	0.0010	-0.0520**	0.0457	0.0547*	0.0802**	0.0490
	(0.0110)	(0.0255)	(0.0607)	(0.0306)	(0.0382)	(0.0651)
Country-Fixed-Effects	YES	YES	YES	YES	YES	YES
Time-Fixed-Effects	YES	YES	YES	YES	YES	YES
Observations	1,411	1,411	1,411	1,411	1,411	1,411
Number of countries	73	73	73	73	73	73
χ^2	2920***	821.3***	367.8***	981.3***	1423***	1027***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(1)	-3.755***	-2.764***	-2.342**	-2.527**	-3.243***	-3.590***
	[0.00]	[0.00]	[0.02]	[0.01]	[0.00]	[0.00]
AR(2)	2.128**	0.847	0.386	0.398	0.311	1.287
	[0.03]	[0.40]	[0.70]	[0.69]	[0.76]	[0.20]

Note: See notes of Table A.5.

Table 3: Inflection points of income per capita

	overall		male			female
	25-34	35-54	25-34	35-54	55-74	55-74
$\hat{\beta}_1$	151.1112	130.5958	277.9982	246.8616	232.6048	120.0029
$\hat{\beta}_2$	-15.3520	-13.8826	-28.4649	-26.709	-24.9591	-12.8491
$\hat{\beta}_3$	0.5140	0.4894	0.9635	0.9573	0.8743	0.4514
$\exp \phi_1$	\$7,304	\$6,498	\$7,727	\$5,266	\$3,459	\$4,022
$\exp \phi_2$	\$60,819	\$25,129	\$46,306	\$22,726	\$53,260	\$43,351

Note: $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$ denote the estimated parameters of per capita income, per capita income squared and per capita income cubic, respectively, from Tables A.5, 1, and 2. ϕ_1 and ϕ_2 are calculated based on equations (A.1) and (A.2), respectively. exp is the exponential operator. The inflection points of per capita income, given in the last two rows, are calculated only when each of the β_1, β_2 and β_3 coefficients are significant at least at the 10% level of significance in Tables A.5-2.

A Online Appendix

A.1 Data description

The choice of the specific 73 countries (reported in Table A.1) and periods used in this study, is purely driven based on data availability.

[Insert Table A.1 around here]

A snapshot of the average number of deaths by suicide across genders and age groups is presented in Table A.2 and their evolution depicted in Figure A.1. One can observe that average deaths are consistently higher among the male population compared to the female population across all age groups. In particular, the male to female deaths by suicide ratio ranges between 1.58 and 4.81. Another pattern readily discernable is that suicides of males (females) are the highest in the 35–74 age group, followed by the age groups of 55–74, 25–34 (75+), 15–24 (25–34) and 75+ (15–24). Moreover, suicides have increased to unprecedented levels in 2010, and one could speculate that this might be due to the global financial crisis.

[Insert Table A.2 around here]

[Insert Figure A.1 around here]

Yet, any conclusions reached by observing the patterns of suicides in numbers will be biased due to the changing population patterns overtime that need to be accounted for. Thus, based on the above data, we convert the number of suicides to suicide rates per 100,000 inhabitants (by diving suicides by population and multiplying the resulting number by 100,000), broken down by age and gender in each of the 73 countries. A snapshot of the average suicide rates across genders and age groups presented in Table A.2 and their evolution presented in Figure A.2 reveals age, time and gender heterogeneity. In particular, male suicide rates are consistently higher than female ones. In addition, overall, male and female suicide rates increase with age, which is in line with the theoretical predictions of Hamermesh and Soss (1974). Moreover, overall, male and female suicide rates peak around the mid-1990s and then follow a slight decreasing trend until the end of

the sample. These features indicate the necessity to take into account the gender–, age– and time- heterogeneity, as well as controlling for country–specific effects in the empirical analysis of suicide rates.

[Insert Table A.3 around here]

[Insert Figure A.2 around here]

Descriptive statistics of the explanatory variables used in this study, as well as those for suicide rates, are reported in Table A.4.

[Insert Table A.4 around here]

A.2 Overall population results

According to Table A.5 which report the main results for the overall population, there is evidence of gender– and age–specificity in the relationship between suicide rates and economic development. We observe that the coefficients of per capita income, including squared and cubic counterparts are positive, negative and positive, respectively, across all ages in Table A.5. Yet, they are only significant for the 25–34 (at the 10% level) and 35–54 (at the 5% level) age groups, under columns (3) and (4) of Table A.5, respectively. This is suggestive of the existence of an N-shaped Suicidal Kuznets curve in the case of the aforementioned age groups.

A.3 Inflection points

Having found evidence of an N-shaped Suicidal Kuznets curve in the aforementioned age groups and genders, we then calculate the inflection points, i.e. the peak and trough of per capita income associated with the N-shaped curve as follows

$$\phi_1 = \frac{-\hat{\beta}_2 - \sqrt{\hat{\beta}_2^2 - 3\hat{\beta}_1\hat{\beta}_3}}{3\hat{\beta}_3} \tag{A.1}$$

and

$$\phi_2 = \frac{-\hat{\beta}_2 + \sqrt{\hat{\beta}_2^2 - 3\hat{\beta}_1\hat{\beta}_3}}{3\hat{\beta}_3} \tag{A.2}$$

where $\hat{\beta}_i$, with i =1,2 and 3, correspond to the coefficients of log of per capita income, its square and its cubic counterparts, respectively obtained from model (1).

A graphical representation of an N-shaped Suicidal Kuznets curve in the context of suicide mortality is given in Figure A.3 in the Appendix. As discussed, the N-shaped curve indicates that suicide mortality first increases with income per capita, but decreases after a certain level. This is how a peak is formed. Along with further increase in income per capita, suicide mortality tends to rise again, which provides a trough in the N-shaped Suicidal Kuznets curve.

[Insert Figure A.3 around here]

A.4 Robustness Analysis

In this section, we perform several robustness checks. First, as the estimation results based on the cubic model (1) in the main text provided evidence of an N-shaped Suicidal Kuznets curve only for a subset of age groups across genders in our sample, we restrict model (1) from the main analysis to a quadratic version as follows

$$S_{ijkt} = \alpha_0 + \alpha_1 S_{ijkt-1} + \beta_1 Y + \beta_2 Y^2 + \beta_3 E_{it} + \beta_5 D_{it} + \gamma_i + \delta_t + \varepsilon_{it}, \qquad \text{(A.3)}$$

where the variables are defined the same as those in the main analysis, and re-estimate model (A.3) again using the two-step System GMM estimator, in order to examine whether such examination could provide evidence for a (inverse) U-shaped Suicidal Kuznets curve. Note that evidence of a (inverse) U-shaped Suicidal Kuznets curve is supported when the coefficients β_1 and β_2 from the estimated model (A.3) are significantly negative (positive) and positive (negative), respectively. This is motivated by the fact that in several age groups across genders in our sample no significant N-shaped relation was found, and the scatter plots presented in Figures 1-6 in the main text were inconclusive between an N-shaped and (inverse) U-shaped Suicidal Kuznets curve.

The results of this analysis for the overall, male and female population are presented in Tables A.6, A.7 and A.8, respectively.

[Insert Tables A.6-A.8 around here]

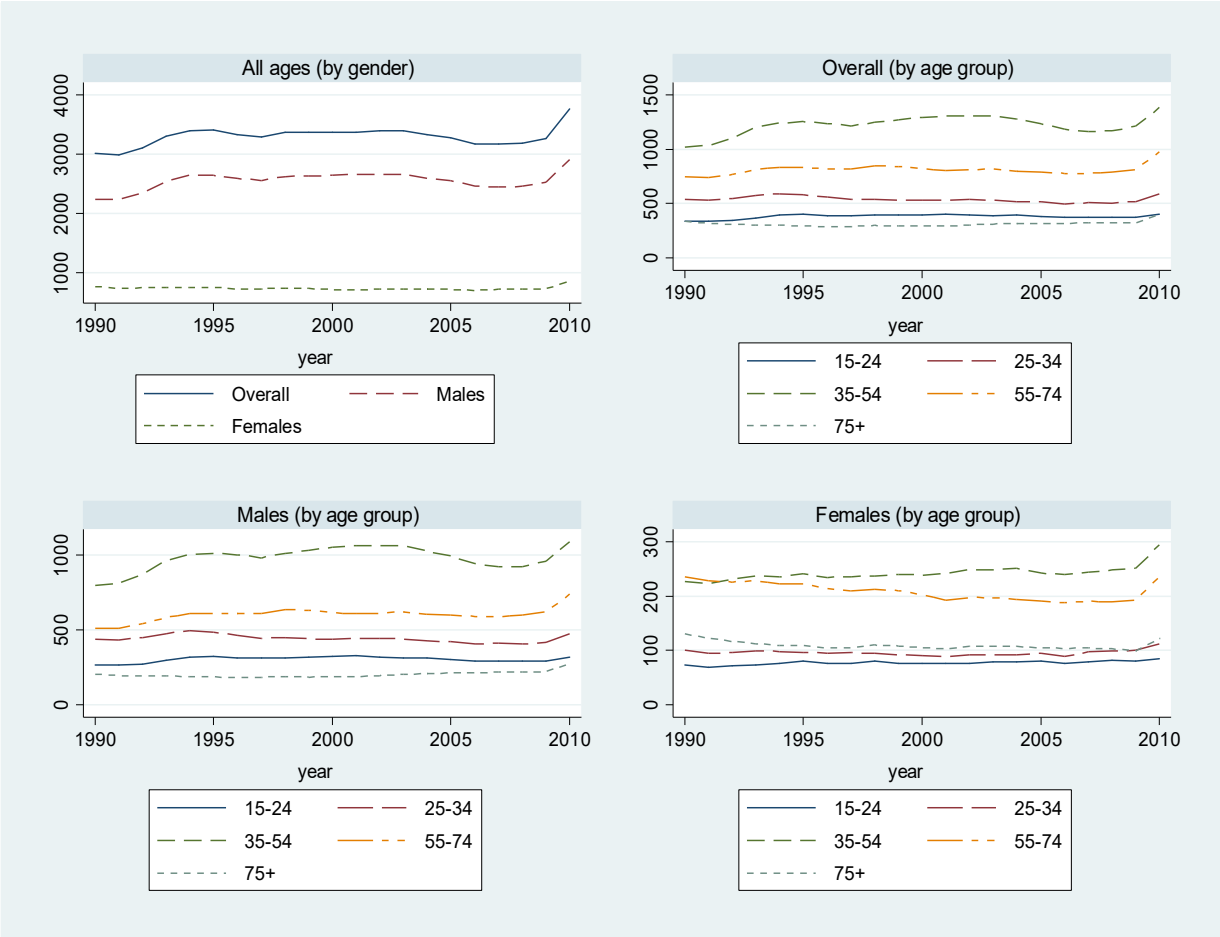
According to these results, we observe that both the coefficients β_1 and β_2 are significantly positive and negative, respectively, only in the case of the overall population in the 25–34 age group (column (3) in Table A.6) and, more specifically, the male population in the 25–34 age group (column (3) in Table A.7). Yet, in the former case, there is evidence of misspecification in the System–GMM model as there is evidence of autocorrelation of order 2. Moreover, the corresponding results (and misspecification tests) of overall and male population in the 25–34 age group presented in column (3) of Tables 2 and 3 in the main analysis, respectively, provide evidence in favour of an N-shaped Suicidal Kuznets Curve over an inverse U-shaped one. The results of the remaining socioeconomic variables are much in line with our main findings resulting from model (1) in the main analysis, and in line with the existing litarature on suicide mortality; thus providing additional robustness evidence related to the socioeconomic predictors used in our analysis. For instance, the results in Tables A.6-A.8 again suggest that male suicide rates are highly sensitive to the state of the macroeconomy (i.e. to changes in economic growth and unemployment rates), while female suicide rates are generally insensitive to the state of the macroeconomy; and are also in line with the literature (see e.g. Brainerd, 2001; Antonakakis and Collins, 2014, 2015).

As a second robustness analysis, we examine the robustness of our baseline System–GMM results based on model (1) given in the main analysis to the fixed effects OLS results and compare the coefficient on the lagged dependent variable under fixed effects (FE) with that under the System–GMM. Since our emphasis on System–GMM is motivated by the downward bias in models that include a lagged dependent variable and exhibit unit effects (Nickell, 1981), the lagged dependent variable coefficient in a correctly specified GMM model should not lie below the lagged dependent variable coefficient in the FE model (Bond, 2002). The results of this analysis, which are not presented but available upon request, reveal that the lagged dependent variable coefficient in the GMM model lies above the lagged dependent variable coefficient in the FE model, thus providing additional robustness to the use of System–GMM and its resulting findings.

References

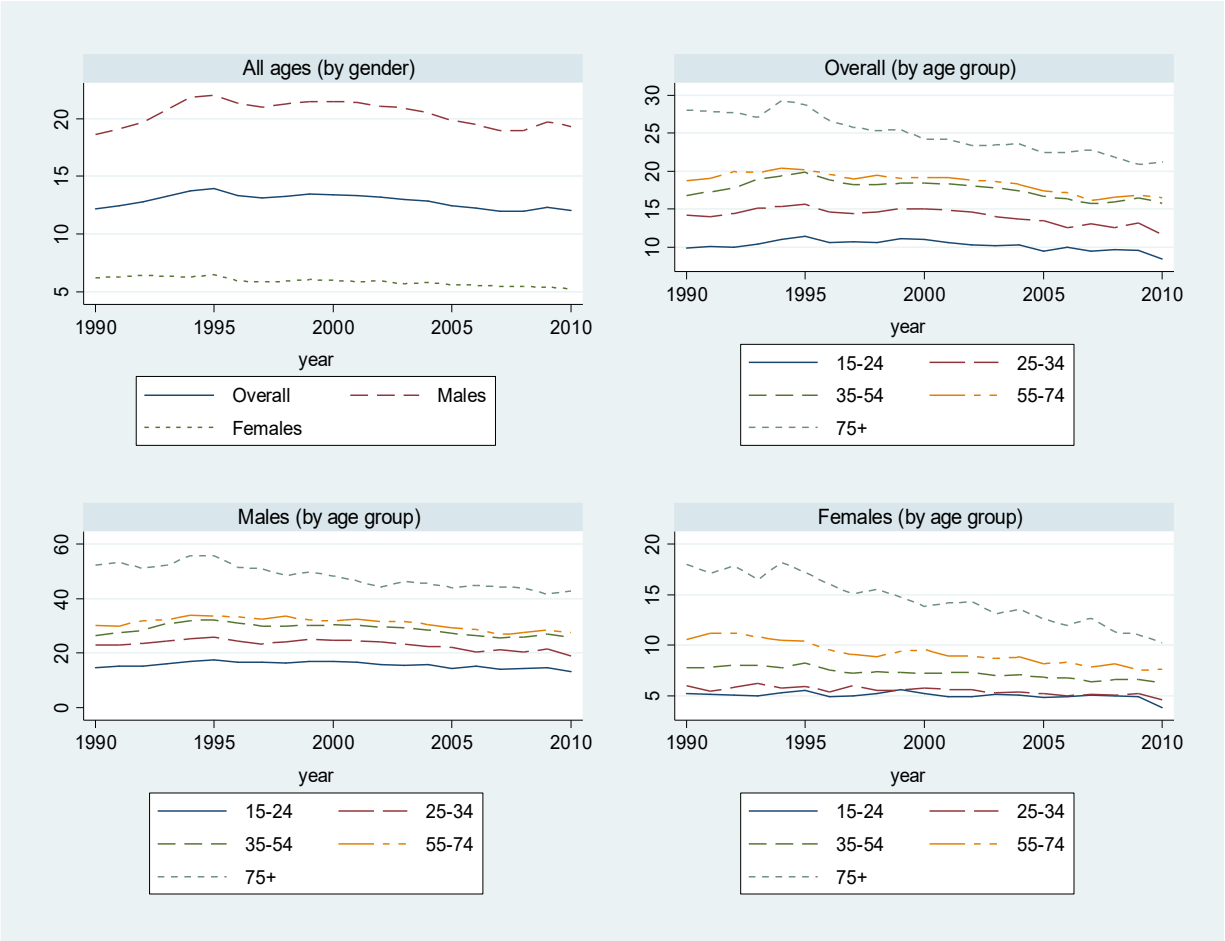
Hamermesh, D. S., Soss, N. M., 1974. An Economic Theory of Suicide. *Journal of Political Economy* 82 (1), 83–98.

Figure A.1: Average deaths due to suicide, by gender and age group



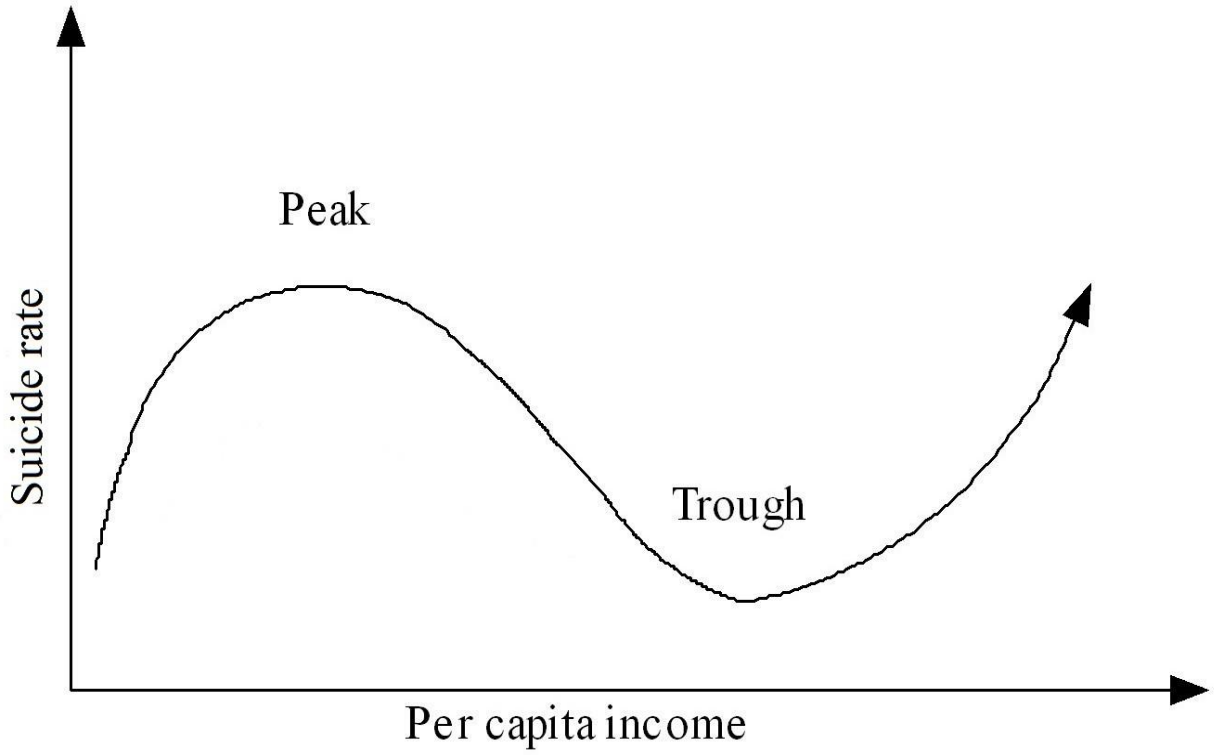
Source: Authors' calculations based on WHO and Official National Statistics databases.

Figure A.2: Average suicide rates (per 100,000 inhabitants), by gender and age group



Source: Authors' calculations based on WHO and Official National Statistics databases.

Figure A.3: Peak and trough of an N-shaped Suicidal Kuznets curve



Source: Authors' calculations.

Table A.1: 73 countries included in the study

Country	Acronym	Country	Acronym
Argentina	ARG	Kuwait	KWT
Armenia	ARM	Kyrgyzstan	KGZ
Australia	AUS	Latvia	LVA
Austria	AUT	Lithuania	LTU
Belarus	BLR	Luxembourg	LUX
Belgium	BEL	Malta	MLT
Belize	BLZ	Mauritius	MUS
Brazil	BRA	Mexico	MEX
Bulgaria	BLG	Moldova, Republic	MDA
Canada	CAN	Netherlands	NED
Chile	CHL	New Zealand	NZL
Colombia	COL	Nicaragua	NIC
Costa Rica	CRI	Norway	NOR
Croatia	HRV	Panama	PAN
Cuba	CUB	Paraguay	PRY
Czech Republic	CZE	Peru	PER
Denmark	DNK	Poland	POL
Dominican Republic	DOM	Portugal	PRT
Ecuador	ECU	Puerto Rico	PRI
El Salvador	SLV	Romania	ROM
Estonia	EST	Russian Federation	RUS
Finland	FIN	Serbia	SRB
France	FRA	Singapore	SGP
Georgia	GEO	Slovakia	SVK
Germany	DEU	Slovenia	SVN
Greece	GRC	South Africa	ZAF
Guatemala	GTM	Spain	ESP
Guyana	GUY	Suriname	SUR
Hong Kong SAR, China	HKG	Sweden	SWE
Hungary	HUN	Switzerland	CHE
Iceland	ISL	TFYR Macedonia	MKD
Ireland	IRE	Ukraine	UKR
Israel	ISR	United Kingdom	UK
Italy	ITA	United States	US
Japan	JPN	Uruguay	URY
Kazakhstan	KAZ	Venezuela	VEN
Korea, Republic	KOR		

Table A.2: Snapshot of average deaths by suicide, by age, gender and selected years in the 73 countries

		Overall	Male	Female	Male/female ratio
1990	All ages	3008	2234	774	2.89
	15–24	341	267	74	3.61
	25–34	537	437	100	4.37
	35–54	1022	795	227	3.50
	55–74	745	509	236	2.16
	75+	336	206	130	1.58
1995	All ages	3401	2642	759	3.48
	15–24	401	321	80	4.01
	25–34	582	485	97	5.00
	35–54	1252	1011	241	4.20
	55–74	832	610	222	2.75
	75+	296	186	110	1.69
2000	All ages	3365	2643	722	3.66
	15–24	397	321	76	4.22
	25–34	529	438	91	4.81
	35–54	1290	1051	239	4.40
	55–74	818	615	203	3.03
	75+	293	188	105	1.79
2005	All ages	3274	2550	724	3.52
	15–24	382	301	81	3.72
	25–34	515	420	95	4.42
	35–54	1233	991	242	4.06
	55–74	792	601	191	3.15
	75+	318	213	105	2.03
2010	All ages	3767	2909	858	3.39
	15–24	401	316	85	3.72
	25–34	585	473	112	4.22
	35–54	1381	1087	294	3.70
	55–74	975	739	236	3.13
	75+	395	273	122	2.24
1990-2010 average	All ages	3296	2554	742	3.44
	15–24	381	304	77	3.95
	25–34	538	442	96	4.60
	35–54	1222	980	242	4.05
	55–74	810	602	208	2.89
	75+	311	202	109	1.85

Note: Authors' calculations based on WHO and Official National Statistics databases.

Table A.3: Snapshot of average suicide rates, by age, gender and selected years in the 73 countries

		Overall	Male	Female	Male/female ratio
1990	All ages	12.20	18.65	6.23	2.99
	15–24	9.85	14.78	5.26	2.81
	25–34	14.27	23.04	6.01	3.83
	35–54	16.76	26.46	7.81	3.39
	55–74	18.73	30.11	10.56	2.85
	75+	28.08	52.18	18.02	2.90
1995	All ages	13.95	22.04	6.48	3.40
	15–24	11.41	17.56	5.57	3.15
	25–34	15.63	25.75	5.98	4.31
	35–54	19.86	32.26	8.27	3.90
	55–74	20.21	33.60	10.39	3.23
	75+	28.80	55.80	17.21	3.24
2000	All ages	13.44	21.48	5.98	3.59
	15–24	10.98	17.03	5.21	3.27
	25–34	15.07	24.85	5.80	4.28
	35–54	18.41	30.33	7.26	4.18
	55–74	19.16	31.91	9.58	3.33
	75+	24.27	48.37	13.84	3.49
2005	All ages	12.46	19.87	5.58	3.56
	15–24	9.53	14.49	4.85	2.99
	25–34	13.50	22.25	5.21	4.27
	35–54	16.70	27.24	6.83	3.99
	55–74	17.41	29.30	8.22	3.56
	75+	22.46	44.04	12.64	3.48
2010	All ages	12.04	19.35	5.25	3.69
	15–24	8.44	13.21	3.84	3.44
	25–34	11.64	18.86	4.65	4.06
	35–54	15.82	25.76	6.33	4.07
	55–74	16.53	27.55	7.65	3.60
	75+	21.26	42.67	10.26	4.16
1990-2010 average	All ages	12.89	20.45	5.88	3.48
	10–24	10.25	15.73	5.06	3.11
	25–34	14.13	23.21	5.52	4.20
	35–54	17.68	28.82	7.28	3.96
	55–74	18.58	30.98	9.24	3.35
	75+	24.88	48.21	14.52	3.32

Table A.4: Descriptive statistics and sources

Variable	Obs	Mean	Std. Dev.	Min	Max	Source
Male Suicide rate (per 100,000 inhabitants)						World Health Organisation,
All ages	1490	20.45	15.46	0.41	83.58	Mortality Database &
15-24	1490	15.73	11.06	0.49	65.52	Official National Statistics
25-34	1490	23.21	17.52	0.63	93.36	
35-54	1490	28.82	24.26	0.42	151.45	
55-74	1490	30.98	23.65	0.78	124.78	
75+	1490	48.21	34.39	0.74	191.00	
Female Suicide rate (per 100,000 inhabitants)						
All ages	1490	5.89	4.03	0.11	25.17	
15-24	1490	5.06	4.06	0.12	33.36	
25-34	1490	5.52	3.82	0.06	30.33	
35-54	1490	7.28	5.05	0.17	26.85	
55-74	1490	9.24	6.83	0.17	37.90	
75+	1490	14.52	13.34	0.28	104.38	
Overall Suicide rate (per 100,000 inhabitants)						
All ages	1490	12.88	9.11	0.26	47.87	
15-24	1490	10.25	6.86	0.33	39.52	
25-34	1490	14.13	10.03	0.38	52.54	
35-54	1490	17.68	13.82	0.33	85.94	
55-74	1490	18.81	13.36	0.48	71.64	
75+	1490	25.52	19.38	0.32	122.30	
GDP per capita, PPP	1529	21492.73	16717.24	1696.364	96711.05	World Development Indicators
(constant 2011 international US$)						
Economic growth	1,457	0.02	0.06	-0.60	0.66	World Development Indicators
Unemployment rate						World Development Indicators
male	1460	8.53	5.48	0.70	37.00	
female	1460	10.36	7.07	0.60	40.10	
total	1460	9.22	5.86	0.70	37.30	
Fertility rate	1525	2.02	0.75	0.90	5.58	World Development Indicators
Share of urban population	1533	70.23	15.82	28.31	100	World Development Indicators
Life expectancy						World Development Indicators
male	1525	70.75	5.46	50.31	87.70	
female	1525	77.38	4.57	52.87	86.44	
total	1525	73.98	4.93	51.56	85.16	

Table A.5: *N*-shaped Suicidal Kuznets Curve? Overall population

	(1)	(2)	(3)	(4)	(5)	(6)
	all	15-24	25-34	35-54	55-74	75+
Lagged Dep. Var.	1.0101***	0.5281***	0.4710***	0.9168***	0.7419***	0.7103***
	(0.0373)	(0.0519)	(0.1497)	(0.0393)	(0.0744)	(0.0706)
Per Capita Income	34.3655	42.5826	151.1112*	130.5958**	88.1711	-95.5058
	(22.7372)	(45.9863)	(78.8301)	(60.8059)	(93.5752)	(107.1579)
Per Capita Income^2	-3.7794	-4.1847	-15.3520*	-13.8826**	-9.4940	10.6911
	(2.4606)	(4.9392)	(8.3625)	(6.4484)	(9.9353)	(11.6444)
Per Capita Income^3	0.1386	0.1385	0.5140*	0.4894**	0.3338	-0.3858
	(0.0878)	(0.1762)	(0.2935)	(0.2257)	(0.3499)	(0.4186)
Growth	-4.4165**	-3.2462**	-3.5182	-7.8354*	-10.7238**	-5.2495
	(1.7507)	(1.3489)	(2.7664)	(4.3902)	(5.1199)	(3.6116)
Unemployment	0.0094	0.0757	0.0994	0.0231	0.0004	0.0353
	(0.0192)	(0.0536)	(0.0690)	(0.0496)	(0.0387)	(0.0735)
Fertility	-0.3169	-1.5337**	-2.0365**	-0.7322	-1.8195**	-1.7447
	(0.2692)	(0.6297)	(0.9262)	(0.4762)	(0.8345)	(1.3091)
Life Expectancy	-0.0553	-0.2789**	-0.6485**	-0.2195	-0.1770	0.1069
	(0.0840)	(0.1215)	(0.2726)	(0.1593)	(0.2039)	(0.1439)
Urban Population	0.0054	0.0210	0.0792	0.1340**	0.0543	0.1637*
	(0.0179)	(0.0512)	(0.0854)	(0.0594)	(0.0825)	(0.0973)
Country-Fixed-Effects	YES	YES	YES	YES	YES	YES
Time-Fixed-Effects	YES	YES	YES	YES	YES	YES
Observations	1,411	1,411	1,411	1,411	1,411	1,411
Number of countries	73	73	73	73	73	73
χ^2	22250***	1416***	834.4***	12131***	3099***	1573***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(1)	-4.183***	-3.470***	-2.518**	-2.943***	-3.073***	-4.025***
	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]
AR(2)	1.951*	0.451	0.597	0.411	0.621	0.325
	[0.05]	[0.65]	[0.55]	[0.68]	[0.53]	[0.74]

Note: Heteroskedasticity and autocorrelation robust standard errors in parentheses; *p*-values in brackets. Instruments are restricted to 2 lags to minimize instrument count. Endogenous variable is the lagged dependent variable. First order serial correlation in first-differenced residuals (AR(1) significant) with no second order serial correlation (AR(2) insignificant) supports the claim that instruments for the System-GMM models are valid. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table A.6: U-shaped Suicidal Kuznets Curve? Overall population

	(1)	(2)	(3)	(4)	(5)	(6)
	all	15-24	25-34	35-54	55-74	75+
Lagged Dep. Var.	0.9392***	0.5212***	0.4898***	0.9294***	0.7452***	0.7065***
	(0.0431)	(0.0567)	(0.1488)	(0.0386)	(0.0792)	(0.0703)
Per Capita Income	-1.9167	8.6512	13.5118*	1.6834	-2.3475	5.3555
	(2.2131)	(5.3307)	(7.9118)	(6.8773)	(14.9815)	(10.7046)
Per Capita Income^2	0.1144	-0.4206	-0.7258*	-0.0670	0.0675	-0.1584
	(0.1222)	(0.2898)	(0.4314)	(0.3822)	(0.8043)	(0.6280)
Growth	-4.6423**	-3.6482***	-3.8703	-8.1100*	-11.7009**	-4.9881
	(1.8702)	(1.3550)	(2.6595)	(4.4809)	(5.1582)	(3.5141)
Unemployment	0.0096	0.0823	0.1124*	0.0278	0.0027	0.0223
	(0.0196)	(0.0557)	(0.0660)	(0.0528)	(0.0394)	(0.0748)
Fertility	-0.2811	-1.5383**	-1.8514*	-0.4775	-1.7210**	-1.8221
	(0.2778)	(0.6539)	(0.9567)	(0.4415)	(0.8491)	(1.2608)
Life Expectancy	-0.0416	-0.3059**	-0.6347**	-0.1998	-0.1775	0.0971
	(0.0904)	(0.1280)	(0.2609)	(0.1585)	(0.2063)	(0.1405)
Urban Population	0.0031	0.0255	0.0675	0.1187**	0.0522	0.1782*
	(0.0183)	(0.0504)	(0.0744)	(0.0533)	(0.0827)	(0.0996)
Country-Fixed-Effects	YES	YES	YES	YES	YES	YES
Time-Fixed-Effects	YES	YES	YES	YES	YES	YES
Observations	1,411	1,411	1,411	1,411	1,411	1,411
Number of country_id	73	73	73	73	73	73
χ^2	28450***	1189***	910.2***	14422***	2392***	1469***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(1)	-4.188***	-3.440***	-2.846***	-3.895***	-3.189***	-4.520***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(2)	1.964**	0.592	1.789*	1.413	1.552	0.552
	[0.05]	[0.55]	[0.07]	[0.16]	[0.12]	[0.58]

Note: Heteroskedasticity and autocorrelation robust standard errors in parentheses; p-values in brackets. Instruments are restricted to 2 lags to minimize instrument count. Endogenous variable is the lagged dependent variable. First order serial correlation in first-differenced residuals (AR(1) significant) with no second order serial correlation (AR(2) insignificant) supports the claim that instruments for the System-GMM models are valid. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table A.7: *U*-shaped Suicidal Kuznets Curve? Male population

	(1) all	(2) 15-24	(3) 25-34	(4) 35-54	(5) 55-74	(6) 75+
Lagged Dep. Var.	0.9929***	0.4523***	0.4802***	0.9235***	0.7339***	0.4754***
	(0.0365)	(0.0797)	(0.1262)	(0.0403)	(0.0939)	(0.0938)
Per Capita Income	-4.8041	13.0133	26.1023*	-6.8187	-2.8473	39.9132*
	(4.3920)	(8.5785)	(14.4900)	(12.3257)	(18.4420)	(23.9427)
Per Capita Income^2	0.2673	-0.6163	-1.3981*	0.3819	0.0115	-1.9337
	(0.2384)	(0.4690)	(0.7875)	(0.6799)	(1.0001)	(1.4616)
Growth	-8.0539**	-2.5804	-8.5781*	-16.8803**	-15.1422**	-6.8732
	(3.3205)	(1.7280)	(4.9978)	(7.7110)	(6.9605)	(7.0812)
Unemployment	0.0308	0.1372**	0.2070**	0.0133	0.0724	0.0367
	(0.0399)	(0.0646)	(0.0954)	(0.0848)	(0.0854)	(0.1479)
Fertility	-0.8214**	-2.9150***	-2.6058*	-1.3625**	-2.5988*	-3.1278
	(0.4052)	(0.8681)	(1.4093)	(0.6680)	(1.3659)	(3.1044)
Life Expectancy	-0.1049	-0.5392***	-1.0787***	-0.3011	-0.2894	-0.1426
	(0.1284)	(0.1735)	(0.3628)	(0.2358)	(0.3772)	(0.4860)
Urban Population	-0.0116	0.1436	0.1304	0.1888*	0.0543	0.4995***
	(0.0381)	(0.1093)	(0.1122)	(0.0973)	(0.1384)	(0.1774)
Country-Fixed-Effects	YES	YES	YES	YES	YES	YES
Time-Fixed-Effects	YES	YES	YES	YES	YES	YES
Observations	1,411	1,411	1,411	1,411	1,411	1,411
Number of countries	73	73	73	73	73	73
χ^2	41219***	979.5***	1447***	11816***	2538***	760.7***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(1)	-4.667***	-3.432***	-2.787***	-3.984***	-3.228***	-3.979***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(2)	1.266	0.685	1.606	1.396	1.647*	0.0943
	[0.20]	[0.49]	[0.11]	[0.16]	[0.10]	[0.92]

Note: Heteroskedasticity and autocorrelation robust standard errors in parentheses; *p*-values in brackets. Instruments are restricted to 2 lags to minimize instrument count. Endogenous variable is the lagged dependent variable. First order serial correlation in first-differenced residuals (AR(1) significant) with no second order serial correlation (AR(2) insignificant) supports the claim that instruments for the System-GMM models are valid. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.

Table A.8: U-shaped Suicidal Kuznets Curve? Female population

	(1)	(2)	(3)	(4)	(5)	(6)
	all	15-24	25-34	35-54	55-74	75+
Lagged Dep. Var.	0.8303***	0.4990***	0.2400**	0.6134***	0.5826***	0.6009***
	(0.0429)	(0.0435)	(0.0984)	(0.0583)	(0.0940)	(0.0810)
Per Capita Income	0.4517	-0.3145	8.1537	4.8661	1.1323	2.7854
	(1.5525)	(3.3591)	(5.8838)	(3.6336)	(6.9685)	(15.1322)
Per Capita Income^2	-0.0099	0.0349	-0.4888	-0.2659	-0.1050	-0.2130
	(0.0827)	(0.1972)	(0.3393)	(0.2085)	(0.3931)	(0.8752)
Growth	-1.5718*	-3.2142***	-0.4705	-1.8929*	-2.9453	-2.6901
	(0.8675)	(1.1767)	(1.3611)	(1.0855)	(2.5839)	(2.9683)
Unemployment	0.0111	0.0403	0.0145	0.0183	0.0096	-0.0296
	(0.0078)	(0.0345)	(0.0248)	(0.0226)	(0.0242)	(0.0539)
Fertility	-0.3980**	-0.7005	-0.1063	-0.3784	-0.8713**	-1.6486
	(0.1860)	(0.4638)	(0.4325)	(0.2901)	(0.4258)	(1.0957)
Life Expectancy	-0.0120	-0.1940	0.1097	0.0323	0.0006	0.0502
	(0.0332)	(0.1398)	(0.1822)	(0.0580)	(0.0843)	(0.2352)
Urban Population	0.0003	-0.0563**	0.0517	0.0515*	0.0717*	0.0552
	(0.0109)	(0.0262)	(0.0581)	(0.0284)	(0.0379)	(0.0658)
Country-Fixed-Effects	YES	YES	YES	YES	YES	YES
Time-Fixed-Effects	YES	YES	YES	YES	YES	YES
Observations	1,411	1,411	1,411	1,411	1,411	1,411
Number of countries	73	73	73	73	73	73
χ^2	2763***	845.5***	405.0***	1220***	1274***	969.5***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
AR(1)	-3.755***	-2.909***	-2.664***	-3.543***	-3.869***	-3.599***
	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]	[0.00]
AR(2)	2.122	0.886	0.979	0.774	0.709	1.342
	[0.03]	[0.37]	[0.33]	[0.44]	[0.48]	[0.18]

Note: Heteroskedasticity and autocorrelation robust standard errors in parentheses; p-values in brackets. Instruments are restricted to 2 lags to minimize instrument count. Endogenous variable is the lagged dependent variable. First order serial correlation in first-differenced residuals (AR(1) significant) with no second order serial correlation (AR(2) insignificant) supports the claim that instruments for the System-GMM models are valid. *, ** and *** indicate significance at 10%, 5% and 1% level, respectively.