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Inflation and the Great Moderation: Evidence from a Large Panel Data Set

Georgios Karras*

Abstract

This paper investigates the relationship between the Great Moderation and two measures of inflation performance: trend inflation and inflation volatility. Using annual data from 1970 to 2011 for a large panel of 180 developed and developing economies, the results show that, as expected, both measures are positively correlated with output volatility. When the two measures are jointly considered, however, and there is sufficient information to identify their effects separately, our empirical findings show that the effect of inflation volatility is positive, while the effect of trend inflation is negative. The implication is that reduced inflation volatility (holding trend inflation constant) helps stabilize the business cycle, whereas lower inflation (holding inflation volatility constant) exacerbates output volatility.

Keywords: Great Moderation, Trend Inflation, Inflation Volatility

JEL Classification: E31, E32

1. Introduction

One of the most notable macroeconomic developments of the last few decades has been the Great Moderation: the apparent decline in output volatility that has characterized the business cycle of the US and other countries. Because of its obvious importance for macroeconomic theory and policy, the Great Moderation has been extensively scrutinized by both theoretical and empirical research[1].

While numerous factors have been proposed as possible explanations for this

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[1] The term "great moderation" originated in Stock and Watson (2002). See Summers (2005), Gali and Gambetti (2009), Coibion and Gorodnichenko (2011), and Carvalho and Gabaix (2013) for other recent examples. Keating (2012) provides an interesting longer-term perspective. Vesselinov (2012) and Gozgor (2013) provide two interesting country-specific studies of the business cycle and its relation to inflation.

widespread smoothing of the business cycle[2], our focus here is the link between the Great Moderation and inflation performance across countries and over time. Beginning with Blanchard and Simon (2001), a more stable inflation environment is one of the main explanations that have been advanced for the Great Moderation. The literature however is divided on whether this means lower *inflation volatility*, as found by Blanchard and Simon (2001), or lower *trend inflation*, as argued by Coibion and Gorodnichenko (2008).

The goal of the present paper is to shed light on this debate, disentangling the effects of inflation volatility from those of trend inflation. This is less than straightforward because of the very high positive correlation between these two inflation variables in most data sets: periods of high trend inflation tend to coincide with periods of high inflation volatility, so that separate identification of their effects on the business cycle is not always possible.

Our approach manages to achieve this using a panel methodology that analyzes annual data from 1970 to 2011 for 180 developed and developing economies. To our knowledge, this is the most extensive data set used for this purpose, and, as it turns out, it suffices to establish the following conclusions. As expected, both trend inflation and inflation volatility are positively correlated with output volatility in bivariate relations. When both are included in the regression, however, our empirical findings show that the effect of inflation volatility is positive, while the effect of trend inflation is negative. The implication is that reduced inflation volatility (holding trend inflation constant) helps stabilize the business cycle, whereas lower inflation (holding inflation volatility constant) exacerbates output volatility. These results are robust to a couple of different definitions of output volatility and a number of different estimation techniques.

The rest of the paper is organized as follows. Section 2 discusses the sources of the data and defines the variables to be used in the estimation. Section 3 outlines the estimation methodology, derives the main empirical results, and implements a number of robustness checks. Section 4 discusses the findings and concludes.

2. The Data

All data are obtained from the UN National Accounts and the data set consists of a panel of the 180 economies for which annual data exist for each of the years 1970-2011. Nominal aggregate income (Y) is measured by GDP in current prices, while real income (y) is measured by GDP in constant (2005) prices. Both series are expressed in national currencies. The price level (P) is then defined as the GDP deflator, $P = Y/y$, and inflation (π) as the annual growth rate of the price level.

Using i to index over countries and t over time, we denote output volatility by $\sigma_{i,t}$, trend inflation by $\overline{\pi}_{i,t}$, and inflation volatility by $\sigma^{\pi}_{i,t}$. All three variables are constructed using rolling 5-year windows, so they are defined over 1975-2011. $\overline{\pi}_{i,t}$ and $\sigma^{\pi}_{i,t}$ are equal to the mean and standard deviation, respectively, of the inflation rate over each 5-year period.

[2] These include a more stable economic structure, stabilizing monetary and/or fiscal policies, and less violent exogenous shocks ("good luck").

To quantify output volatility, $\sigma_{i,t}$, two techniques are used. First, we compute the standard deviation of the real GDP growth rate, again calculated over rolling 5-year windows. We denote this simple measure by $\sigma_{i,t}^{\Delta y}$. In addition, we decompose the real GDP series between the trend and a cyclical component, using the Hodrick-Prescott (HP) filter, proposed by Hodrick and Prescott (1980, 1997), and extensively used in the business-cycle literature. Letting $x_{i,t} = \ln(y_{i,t})$ denote (the log of) real GDP, the HP filter defines its trend, $\overline{x}_{i,t}$, as the component that minimizes

$$\sum_{t=1}^{T}\left(x_{i,t}-\overline{x}_{i,t}\right)^2+\lambda\sum_{t=2}^{T-1}\left[\left(\overline{x}_{i,t+1}-\overline{x}_{i,t}\right)-\left(\overline{x}_{i,t}-\overline{x}_{i,t-1}\right)\right]$$

for $\lambda > 0$. In the empirical section below we report results for $\lambda = 100$, the value suggested by Hodrick and Prescott for annual data, but we also tried $\lambda = 6.25$, the smoothing parameter value recommended by Ravn and Uhlig (2002) for annual data (with no appreciable difference in our findings). The cyclical output component is then simply given by $x_{i,t} - \overline{x}_{i,t}$, and its standard deviation over the rolling 5-year windows, $\sigma_{i,t}^{HP}$, provides our second measure of business-cycle volatility.

The Appendix provides a list of the 180 economies[3]. As the Appendix makes clear, the sample of countries is quite diverse, including economies which are at various stages of development, and have had very different growth and inflation experiences.

Figure 1 plots the simple (unweighted) averages of our two measures of business-cycle volatility, $\sigma_{i,t}^{\Delta y}$ and $\sigma_{i,t}^{HP}$, over all 180 economies. First, Figure 1 shows that the two measures move closely together, thus providing very similar information about the behavior of the underlying $\sigma_{i,t}$ (and accounting for the robustness of our empirical results in the next section)[4].

In addition, and more to our purpose here, Figure 1 clearly illustrates that the "Great Moderation" is a global phenomenon. Indeed, with two notable exceptions, both measures of cyclical output volatility have steadily declined over the last four decades (the two exceptions are 1988-1992 and the period following the 2008 financial crisis).

The next two Figures visualize the relationship between output volatility and inflation performance, using again simple averages over all 180 economies. The $\sigma_{i,t}^{\Delta y}$ measure of output volatility is combined with trend inflation on Figure 2, and with inflation volatility on Figure 3. Both Figures paint a similar picture. Particularly since the mid-1980s, output volatility is positively related with both trend inflation and inflation volatility, as expected: lower and more stable inflation has coincided with a smoother business cycle. Note however, that trend inflation and inflation volatility evolve so similarly that telling which of the two is more closely related to output volatility is far from easy. This will be the subject of the more formal empirical investigation of the next section.

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[3] As already noted, country selection has been dictated by data availability only.

[4] For the entire panel data set, $corr\left(\sigma_{i,t}^{\Delta y}, \sigma_{i,t}^{HP}\right) = 0.88$.

3. Empirical Evidence

3.1 Trend Inflation

We start with a simple relationship between output volatility and trend inflation. Using Coibion and Gorodnichenko's (2008) empirical specification, the estimated model is:

$$\sigma_{i,t} = w_i + v_t + \alpha \cdot \overline{\pi}_{i,t} + u_{i,t}, \quad (1)$$

where $\sigma_{i,t}$ is output volatility; $\overline{\pi}_{i,t}$ trend inflation; i is indexing over countries and t over time; w and v represent country- and time-specific effects; and α, a parameter to be estimated, captures the effect of trend inflation on output volatility.

Table 1 presents the results. Panel A includes all observations, and the estimated α's are found to be positive and highly statistically significant. They are also robust to whether the regression includes fixed or random effects, and to whether $\sigma_{i,t}$ is proxied by $\sigma_{i,t}^{\Delta y}$ or $\sigma_{i,t}^{HP}$. However, they are quite small, questioning the economic significance of the effects. This small size, however, could be the result of a relatively small number of extremely high inflation values that flatten the regression line.

To check this, Panel B of Table 1 repeats the exercise excluding inflation values higher than 100%[5]. The estimated α's remain positive, highly statistically significant, and robust to the various specifications, but they also become much larger, indicating economically significant effects. Panel C pursues this further, excluding inflation values higher than 30%[6]. The estimated α's are once again positive, highly statistically significant, and robust, while now they become even more sizable. These results therefore suggest that the effect of *trend inflation* on business-cycle volatility is positive and significant.

3.2 Inflation Volatility

Next, we move to the relationship between output volatility and inflation volatility. The estimated model becomes:

$$\sigma_{i,t} = w_i + v_t + \beta \cdot \sigma_{i,t}^{\pi} + u_{i,t}, \quad (2)$$

where $\sigma_{i,t}^{\pi}$ is inflation volatility, and β, a parameter to be estimated, captures the effect of inflation volatility on output volatility.

Table 2 presents the results of estimating model (2). Panel A starts by including all observations, showing that the estimated β's are positive, highly statistically significant, and robust to the two different measures of $\sigma_{i,t}$ and to whether fixed or random effects are

[5] This reduces the sample size from 6660 to 6485 observations, or by 2.6%.

[6] This further reduces the sample size to 6081 observations, or by 8.7% of the original size.

included. Like the estimated α's of Table 1, however, the point estimates of these β's are very small, casting doubt on the economic significance of their effects. It turns out again, however, that this is because of the small number of observations with very large inflation values that flatten the regression line.

To confirm this, the next two panels of Table 2 repeat the estimation of model (2), excluding inflation values higher than 100% (Panel B) or higher than 30% (Panel C), following the strategy of Table 1. It is apparent that the estimated β's are still positive, highly statistically significant, and robust to the various specifications, but in addition they increase substantially in size indicating effects that are much more economically significant. These results therefore suggest that the effect of *inflation volatility* on business-cycle volatility is positive and significant.

3.3 Trend Inflation v Inflation Volatility

Our findings so far show that output volatility ($\sigma_{i,t}$) is positively correlated with both trend inflation ($\overline{\pi}_{i,t}$) and inflation volatility ($\sigma^{\pi}_{i,t}$). If $\overline{\pi}_{i,t}$ and $\sigma^{\pi}_{i,t}$ are highly correlated themselves, however, these findings would not necessarily mean that both variables have an independent effect on the business cycle. And, as expected, the correlations between $\overline{\pi}_{i,t}$ and $\sigma^{\pi}_{i,t}$ are rather high: 0.96 for the full sample (Panels A in the Tables), 0.75 for the sample excluding trend inflation greater than 100% (Panels B), and 0.50 for the sample excluding trend inflation greater than 30% (Panels C). Such high correlations mean that, even if only one of the two inflation variables economically mattered for cyclical variability, both would appear to be correlated with $\sigma_{i,t}$ in the bivariate regressions of models (1) and (2).

To address this issue and determine which of the two inflation variables matters the most, we now estimate the nested model:

$$\sigma_{i,t} = w_i + v_t + \alpha \cdot \overline{\pi}_{i,t} + \beta \cdot \sigma^{\pi}_{i,t} + u_{i,t}, \tag{3}$$

where notation is as before, with the following difference in interpretation: α now captures the effect of trend inflation on output volatility, holding inflation volatility constant; while β represents the effect of inflation volatility on output volatility, holding trend inflation constant[7].

The results are presented in Table 3, which is organized like the last two Tables. Begin with Panel A which includes all observations. The estimated α's are all positive, while the estimated βs are all negative. We note however that all coefficients are very small in magnitude and largely statistically insignificant, across the different specifications. This may not be very helpful, but it is easily explained given the extremely high correlation (0.96) between $\overline{\pi}_{i,t}$ and $\sigma^{\pi}_{i,t}$, which apparently leaves very little independent information to be used in the identification of α and β in the multivariable framework of model (3).

[7] This is similar to the model used by Blanchard and Simon (2001).

Panel B of Table 3 estimates the model excluding trend inflation values higher than 100%. The picture now changes drastically. Both estimated α s and β s are substantially larger (in absolute value) and all are highly statistically significant. It is obvious that the reduced, though still high, correlation between $\bar{\pi}_{i,t}$ and $\sigma^{\pi}_{i,t}$ in this sample (0.75) allows for enough independent variability to identify their separate effects more precisely. Interestingly, the estimated β s are all positive (as expected), while the estimated α s are all negative (the "wrong" sign)[8]. The implication is that reduced inflation volatility (holding trend inflation constant) helps stabilize the business cycle, whereas lower inflation (holding inflation volatility constant) exacerbates output volatility.

Panel C of Table 3 estimates model (3), excluding inflation values higher than 30%. Estimated coefficients are generally greater (in absolute value), but the signs and statistical significance remain the same with Panel B. In particular, the estimated β s are positive while the estimated α s are negative. Once more the results suggest that the effect of inflation volatility on output volatility is positive when trend inflation is controlled for; whereas the effect of trend inflation on output volatility is negative when inflation volatility is controlled for. This is consistent with Blanchard and Simon's (2001) finding that it is the lower *inflation volatility* (rather than lower *trend inflation*) that has mattered more for the reduction in output volatility.

4. Discussion and Conclusions

This paper investigated the relationship between the Great Moderation and two measures of inflation performance: trend inflation and inflation volatility. Using annual data from 1970 to 2011 for a large panel of 180 developed and developing economies, the results show that, as expected, both measures are positively correlated with output volatility.

When both measures are included in the regression, however, and there is sufficient information to identify their effects separately, our empirical findings show that the effect of inflation volatility is positive, while the effect of trend inflation is negative. The implication is that reduced inflation volatility (holding trend inflation constant) helps stabilize the business cycle, whereas lower inflation (holding inflation volatility constant) exacerbates output volatility. These results are found to be robust to a number of different empirical specifications and estimation techniques.

These findings have obvious policy implications. The most obvious is that inflation volatility, rather than trend inflation, matters the most for the severity of the business cycle. It follows that it has been reduced inflation volatility, rather than reductions in trend inflation, that contributed the most to the Great Moderation, as argued by Blanchard and Simon (2001).

Even more strongly, our estimates suggest that, *holding inflation volatility constant*,

[8] Interestingly, these are the same with the signs obtained by Blanchard and Simon (2001), though in a much smaller panel data set.

reducing trend inflation ends up deteriorating the business cycle. The robustness of this somewhat unexpected result should be the subject of further research, but if confirmed by additional evidence this finding may help resolve the apparent paradox of the output volatility reversal of the post-2008 period in an environment of very low inflation.

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Table 1

Estimated Model: $\sigma_{i,t} = w_i + v_t + \alpha \cdot \overline{\pi}_{i,t} + u_{i,t}$

PANEL A: Full Sample

	$\sigma_{i,t} = \sigma_{i,t}^{\Delta y}$			$\sigma_{i,t} = \sigma_{i,t}^{HP}$		
	OLS	FE	RE	OLS	FE	RE
α	0.0006**	0.0006**	0.0007**	$7.4 \cdot 10^{-6}$**	$5.2 \cdot 10^{-6}$**	$5.4 \cdot 10^{-6}$**
	(0.0002)	(0.0002)	(0.0002)	$(2.0 \cdot 10^{-6})$	$(1.8 \cdot 10^{-6})$	$(1.8 \cdot 10^{-6})$

PANEL B: Sample with $\overline{\pi}_{i,t} < 100\%$

	$\sigma_{i,t} = \sigma_{i,t}^{\Delta y}$			$\sigma_{i,t} = \sigma_{i,t}^{HP}$		
	OLS	FE	RE	OLS	FE	RE
α	0.0333**	0.3421**	0.0360**	$3.3 \cdot 10^{-4}$**	$3.2 \cdot 10^{-4}$**	$3.4 \cdot 10^{-4}$**
	(0.0040)	(0.0043)	(0.0042)	$(3.6 \cdot 10^{-5})$	$(3.9 \cdot 10^{-5})$	$(3.7 \cdot 10^{-5})$

PANEL C: Sample with $\overline{\pi}_{i,t} < 30\%$

	$\sigma_{i,t} = \sigma_{i,t}^{\Delta y}$			$\sigma_{i,t} = \sigma_{i,t}^{HP}$		
	OLS	FE	RE	OLS	FE	RE
α	0.0673**	0.0757**	0.0837**	0.0333**	0.0006**	0.0006**
	(0.0087)	(0.0099)	(0.0094)	$(7.8 \cdot 10^{-5})$	$(8.7 \cdot 10^{-5})$	$(8.3 \cdot 10^{-5})$

Notes: Business-cycle volatility, $\sigma_{i,t}$, is measured by $\sigma_{i,t}^{\Delta y}$, the standard deviation of real GDP growth, or $\sigma_{i,t}^{HP}$, the standard deviation of the Hodrick-Prescott detrended (log) real GDP; $\overline{\pi}_{i,t}$ is trend inflation; w_i and v_t represent fixed ("FE") or random ("RE") country and time effects (not reported). "OLS" replaces w_i and v_t by a simple constant term (also not reported). Usable observations are 6660 for Panel A, 6485 for Panel B, and 6081 for Panel C. Estimated standard errors in parentheses. ** and * denote statistical significance at the 1% and 5% significance levels.

Table 2

Estimated Model: $\sigma_{i,t} = w_i + v_t + \beta \cdot \sigma^{\pi}_{i,t} + u_{i,t}$

PANEL A: Full Sample

	$\sigma_{i,t} = \sigma^{\Delta y}_{i,t}$			$\sigma_{i,t} = \sigma^{HP}_{i,t}$		
	OLS	FE	RE	OLS	FE	RE
β	0.0003**	0.0003**	0.0003**	$3.7 \cdot 10^{-6}$**	$2.7 \cdot 10^{-6}$**	$2.8 \cdot 10^{-6}$**
	(0.0001)	(0.0001)	(0.0001)	$(1.2 \cdot 10^{-6})$	$(1.0 \cdot 10^{-6})$	$(1.0 \cdot 10^{-6})$

PANEL B: Sample with $\bar{\pi}_{i,t} < 100\%$

	$\sigma_{i,t} = \sigma^{\Delta y}_{i,t}$			$\sigma_{i,t} = \sigma^{HP}_{i,t}$		
	OLS	FE	RE	OLS	FE	RE
β	0.1018**	0.0701**	0.0736**	$9.3 \cdot 10^{-4}$**	$6.3 \cdot 10^{-4}$**	$6.6 \cdot 10^{-4}$**
	(0.0044)	(0.0044)	(0.0043)	$(4.0 \cdot 10^{-5})$	$(4.0 \cdot 10^{-5})$	$(3.9 \cdot 10^{-5})$

PANEL C: Sample with $\bar{\pi}_{i,t} < 30\%$

	$\sigma_{i,t} = \sigma^{\Delta y}_{i,t}$			$\sigma_{i,t} = \sigma^{HP}_{i,t}$		
	OLS	FE	RE	OLS	FE	RE
β	0.2665**	0.1983**	0.2090**	0.0021**	0.0014**	0.0015**
	(0.0084)	(0.0092)	(0.0089)	$(7.6 \cdot 10^{-5})$	$(8.3 \cdot 10^{-5})$	$(8.0 \cdot 10^{-5})$

Notes: See Table 1. $\sigma^{\pi}_{i,t}$ is the standard deviation of inflation.

Table 3

Estimated Model: $\sigma_{i,t} = w_i + v_t + \alpha \cdot \bar{\pi}_{i,t} + \beta \cdot \sigma^{\pi}_{i,t} + u_{i,t}$

PANEL A: Full Sample

	$\sigma_{i,t} = \sigma^{\Delta y}_{i,t}$			$\sigma_{i,t} = \sigma^{HP}_{i,t}$		
	OLS	FE	RE	OLS	FE	RE
α	0.0017*	0.0012	0.0013	$1.8 \cdot 10^{-5}$*	$9.1 \cdot 10^{-6}$	$1.0 \cdot 10^{-5}$
	(0.0008)	(0.0007)	(0.0007)	$(7.5 \cdot 10^{-6})$	$(6.3 \cdot 10^{-6})$	$(6.3 \cdot 10^{-6})$
β	–0.0007	–0.0003	–0.0004	$-6.7 \cdot 10^{-6}$	$-2.4 \cdot 10^{-6}$	$-3.0 \cdot 10^{-6}$
	(0.0005)	(0.0007)	(0.0004)	$(4.4 \cdot 10^{-6})$	$(3.7 \cdot 10^{-6})$	$(3.7 \cdot 10^{-6})$

PANEL B: Sample with $\bar{\pi}_{i,t} < 100\%$

	$\sigma_{i,t} = \sigma^{\Delta y}_{i,t}$			$\sigma_{i,t} = \sigma^{HP}_{i,t}$		
	OLS	FE	RE	OLS	FE	RE
α	–0.0768**	–0.0413**	–0.0426**	$-6.3 \cdot 10^{-4}$**	$-3.5 \cdot 10^{-4}$**	$-3.5 \cdot 10^{-4}$**
	(0.0057)	(0.0065)	(0.0063)	$(5.2 \cdot 10^{-5})$	$(5.9 \cdot 10^{-5})$	$(5.7 \cdot 10^{-5})$
β	0.1675**	0.1027**	0.1075**	0.0015**	$9.0 \cdot 10^{-4}$**	$9.4 \cdot 10^{-4}$**
	(0.0066)	(0.0067)	(0.0066)	$(5.9 \cdot 10^{-5})$	$(6.1 \cdot 10^{-5})$	$(6.0 \cdot 10^{-6})$

PANEL C: Sample with $\bar{\pi}_{i,t} < 30\%$

	$\sigma_{i,t} = \sigma^{\Delta y}_{i,t}$			$\sigma_{i,t} = \sigma^{HP}_{i,t}$		
	OLS	FE	RE	OLS	FE	RE
α	–0.0800**	–0.0419**	–0.0391**	–0.0006**	–0.0002*	–0.0002*
	(0.0093)	(0.0112)	(0.0106)	$(8.5 \cdot 10^{-5})$	(0.0001)	$(9.5 \cdot 10^{-5})$
β	0.3074**	0.2192**	0.2282**	0.0024**	0.0015**	0.0016**
	(0.0096)	(0.0108)	(0.0105)	$(8.7 \cdot 10^{-5})$	$(9.6 \cdot 10^{-5})$	$(9.4 \cdot 10^{-5})$

Notes: See Tables 1 and 2.

Figure 1

Two measures of Real GDP Volatility

Unweighted Averages of 180 Economies: 1975-2011

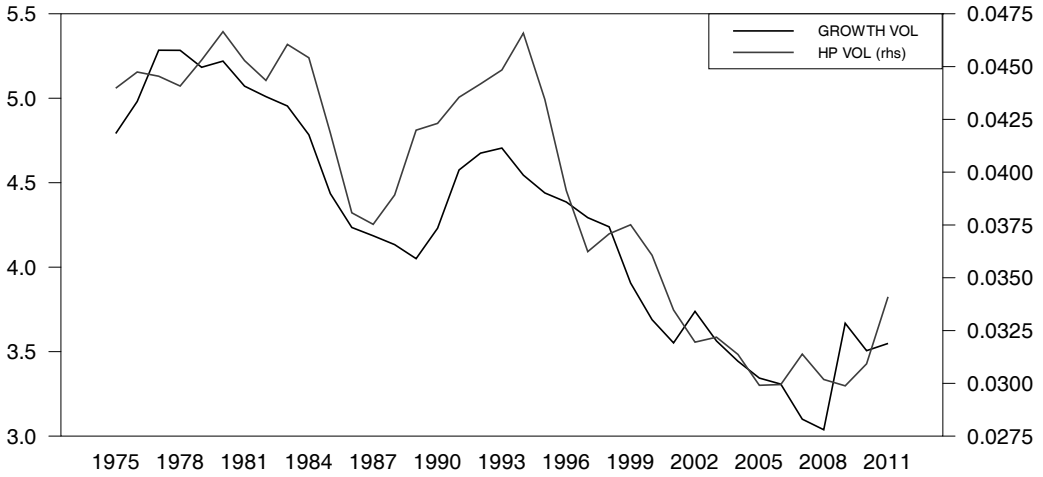


Figure 2

Real GDP Growth Volatility and Trend Inflation

Unweighted Averages of 180 Economies: 1975-2011

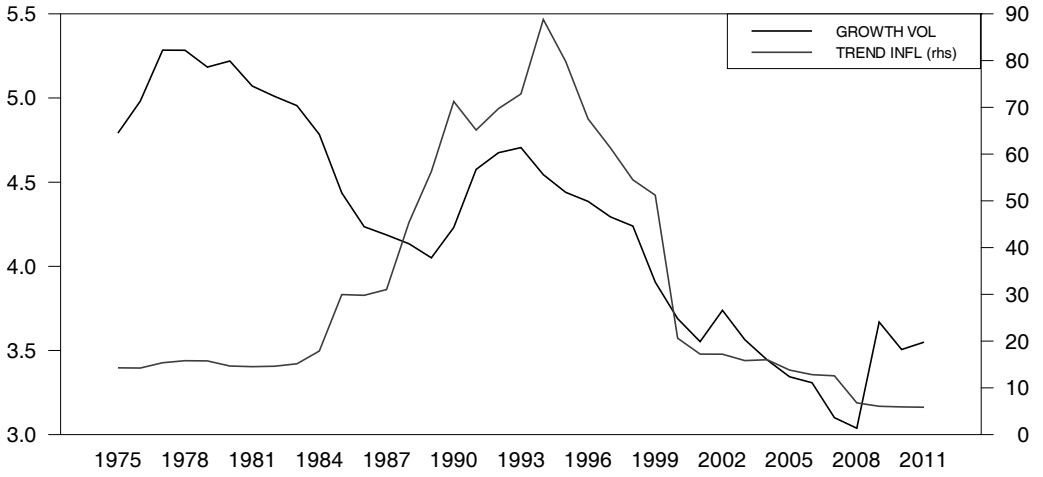
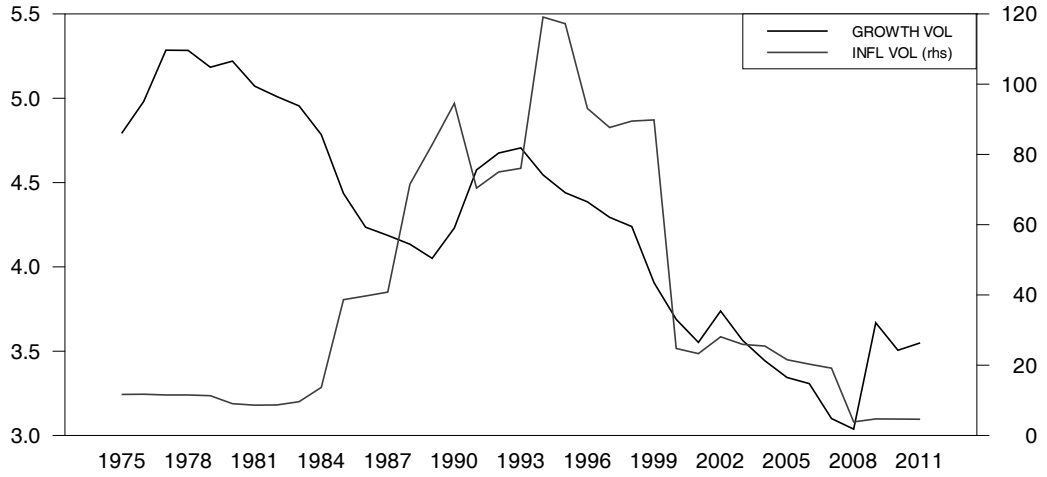


Figure 3

Real GDP Growth Volatility and Inflation Volatility

Unweighted Averages of 180 Economies: 1975-2011



Appendix

List of the 180 Economies

Afghanistan, Albania, Algeria, Andorra, Angola, Anguilla, Antigua and Barbuda, Argentina, Aruba, Australia, Austria, Bahamas, Bahrain, Bangladesh, Barbados, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia, Botswana, Brazil, British Virgin Islands, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Cayman Islands, Central African Republic, Chad, Chile, China: People's Republic of, China: Hong Kong SAR, China: Macao SAR, Colombia, Comoros, Congo, Cook Islands, Costa Rica, Côte d'Ivoire, Cuba, Cyprus, Democratic People's Republic of Korea, Democratic Republic of the Congo, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Fiji, Finland, France, French Polynesia, Gabon, Gambia, Germany, Ghana,
Greece, Greenland, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran: Islamic Republic of, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kiribati, Kuwait, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, Libya, Liechtenstein, Luxembourg, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia (Federated States of), Monaco, Mongolia, Montserrat, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Netherlands, Netherlands Antilles, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, Norway, Occupied Palestinian Territory, Oman, Pakistan,
Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Republic of Korea, Romania, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, San Marino, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, Somalia, South Africa, Spain,
Sri Lanka, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turks and Caicos Islands, Tuvalu, Uganda, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United Republic of Tanzania: Mainland, United States, Uruguay, Vanuatu, Venezuela (Bolivarian Republic of), Viet Nam, Zambia, Zimbabwe

Spending and Growth: A Modified Debt to GDP Dynamic Model

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Abstract

The paper addresses a topical issue – how expansionary fiscal policy affects the debt to GDP ratio. It examines whether the projected future economic growth (stimulated by government spending) is sustained with the resulting national debt. It is discussedif government investment in infrastructure is an effective approach to boost the economy in times of economic downturn. The authors develop the debt to GDP ratio dynamics model and perform a series of simulations (based on US data) to forecast the evolution of the debt to GDP ratio over a 10-year horizon. It is shown that for the data characterizing the current state of the U.S. economy the government investment in infrastructure cannot decrease the debt to GDP ratio.

Keywords: debt dynamics, debt to GDP ratio dynamics, investment in infrastructure, stimulus

JEL Classification: C20, C60, O40

1. Introduction

The 2008 global financial crisis has resulted in large deficits and public debt burdens across many countries. According to IMF (2009) estimates, the level of public debt for advanced countries would reach over 100 percent of GDP by 2014, a level unseen since World War II. The United States has a huge national debt (about 16.1 trillion dollars in 2012) and it has surpassed 100% of gross domestic product. The European Union average debt was about 85% of GDP in 2012. That is why Germany and the majority of EU countries have undertaken austerity measures. Nevertheless, even as constraints on spending and borrowing have grown, many governments have been emphasizing the importance of infrastructure in assisting economic growth. A number of countries have explicitly recognized this as part of their stimulus packages. The $840 billion stimulus package enacted by the U.S. Congress contained $105 billion for infrastructure, which is significantly less than $2.5 trillion worth of stimulus launched by the Chinese government, most of which went to special purpose

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vehicles to build rail, bridges, airports, condo buildings, etc. Many economists consider the over-investment undertaken in China as an attempt to avert an economic slowdown.

The two camps of economists have different views concerning how to improve the economy in times of economic downturn. In contrast to those who consider government spending on infrastructure as an efficient strategy and support the approach based on additional government borrowing with a hope that this will help decrease the debt in the future, another group of economists, concerned with high government debt which, as they believe, can inevitably undermine economic growth, supports austerity measures.

The debt to GDP ratio is widely used to measure the impact of debt on the economy. It was introduced similar to the bank debt ratio – total debt as a percentage of income – determining the level at which businesses can afford to owe. There exists justifiable criticism of the debt to GDP ratio as the insufficiently informative and most overused economic index. The mentioned ratio as if ignores such important parameters as the interest rates associated with the debt and when the debt matures. Some economists state that the debt to GDP is a very poor measure of the health of a nation or its economy; the best measures are real GDP per capita, real GDP growth rates, unemployment rate, and inflation rate. Nevertheless, many economists and leading economic organizations use GDP and debt to GDP to evaluate the health of the country's economy, its ability to handle the increasing debt load and to predict the future economic environment. The European Union requires that member state's public debt not exceed 60 percent of GDP.

The literature on the relationship between government debt and economic growth is scarce. According to Reinhart and Rogoff (2009), debt to GDP ratios below a threshold of 90 percent of GDP ratios have no significant impact on growth; above the threshold of 90%, median growth rates fall by 1%, and average growth falls considerably more. Recently, Herndon et al. (2013) found an error in calculation of the threshold; they indicate that the average real GDP growth rate for countries carrying a debt to GDP ratio of over 90 % is actually 2.2 percent, and the relationship between public debt and GDP growth varied significantly by time period and country. Despite the mentioned error, the obtained results of Reinhart and Rogoff (2010) are qualitatively correct. However, the findings of both Herndon et al. (2013) and Reinhart and Rogoff (2010) are suggestive, rather than conclusive, since they operate with past data. It is dangerous to build future financial policy by using blindly such findings since pictures of the world economy are changing with time, and statistics of the past may not apply to a current or future economic situation in a country. More reliable mathematical models should be developed.

Paul Krugman questioned the validity of the above finding related to the linkage between government debt and economic growth (Krugman, 2012). He criticized the conclusion that stepping over the 90% "border" of the debt to GDP ratio is harmful for growth and believes that increasing government debt can increase growth, if the money is invested well, which he links to infrastructure spending (Krugman, 2012). Although the impact of government spending programs in the past that were intended to increase economic growth by using infrastructure-focused stimulus packages was very modest and did not restore economic activity, Krugman (2012) states that "fiscal expansion will be

even better for America's future if a large part of the expansion takes the form of public investment – of building roads, repairing bridges and developing new technologies, all of which makes the nation richer in the long run". For him big government spending is a solution of problems of high unemployment and low GDP growth: "But the essential point is that what we really need to get out of this current depression is another burst of government spending".

Krugman believes that it is the debt to GDP ratio that matters and not the debt itself. In Krugman (2009) he wrote: "How, then, did America pay down its debt? Actually, it didn't... But the economy grew, so the ratio of debt to GDP fell, and everything worked out fiscally... Which brings me to a question a number of people have raised: maybe we can pay the interest, but what about repaying the principal? ...But why would we have to do that? Again, the lesson of the 1950s - or, if you like, the lesson of Belgium and Italy, which brought their debt-GDP ratios down from early 90s levels - is that you need to stabilize debt, not pay it off; economic growth will do the rest". Being a supporter of Keynesian economic doctrine, he believes that it is governments' role to create jobs – more teachers, construction workers for public works projects, etc.,– when the private sector cannot, and that such a strategy results in economic growth, so the ratio of debt to GDP should fall, and everything should work out fiscally.

Research results related to the debt to GDP ratio were based mostly on analysis of the existing statistical economic data. Different conclusions and following disputes reflect different interpretation by economists of the available statistical material. Using regression models and/or the existing historic data most of the above mentioned publications examined the impact of government spending to stimulate the economy on GDP or analyzed the influence of the debt to GDP ratio on economic growth. However, they did not establish the direct relationship between GDP, the related government spending and the debt to GDP ratio.

This paper considers a model describing the debt to GDP ratio dynamics and examines the linkage between the GDP growth rate, the related government spending (its effect is presented by related fiscal multipliers) and the debt to GDP ratio. Based on the developed model giving the lower estimate of the debt to GDP ratio, the impact of expansionary fiscal policy intended to reduce unemployment and increase economic growth by using infrastructure-focused stimulus packages is analyzed.

The paper is organized as follows. Section 2 discusses the developed debt to GDP ratio dynamics model, its specifics – the ability to obtain the lower estimate of the debt to GDP ratio. Section 3 describes the simulation results grounded upon the developed theoretical model. In Section 4, some conclusions are drawn.

2. Debt to GDP ratio dynamics

The debt dynamics can be described by the following equation

$$D_{t+1} - D_t = rD_t + G_{t+1} - T_{t+1} \tag{1}$$

where D is general government debt; r is the interest rate on debt; G and T are government purchases (expenditure excluding interest payments on the debt) and revenues, respectively; the lower index indicates discrete time - years.

Government revenues are presented in the form

$$T_t = \tau Y_t \tag{2}$$

where τ is a tax rate and the Cobb-Douglas function Y_t represents GDP (in many models the Cobb-Douglas function is used as the estimation and forecasting of GDP from the supply side)

$$Y_t = AK_t^{\alpha} L_t^{\beta} \tag{3}$$

where A is a measure of technology, α and β are the output elasticities of capital K and lab or L, respectively.

The Cobb-Douglas functional form of production functions and its modifications are widely used to represent the relationship of an output to inputs in macro- and microeconomic models (see, e.g., Glomm and Ravikumar, 1997; Yanushevsky, 1992).

Various economic models, starting from the Solow growth model (see, e.g., Romer, 2006), used the Cobb-Douglas function to examine long-run growth analytically and determine the economy's balanced-growth path. If initially capital was represented by one parameter, later in some models private and public capital were considered separately (see, e.g., Aschauer's, 1989; Cassou and Lansing, 1998; Glomm and Ravikumar, 1994; 1997; Lynde and Richmond, 1993; Munnell, 1990). Economists began to study the influence of government spending on consumption-savings decisions in models which allow the possibility of persistent growth; long-run growth models with productive government spending combine several goods and services, such as roads and highways, sewer systems, harbors, public sector R&D, together into one category called public capital. Government spending is maintained by taxes and government borrowing. To obtain visible analytical results the mentioned models contain unrealistic assumptions, such as that the government's budget is balanced and tax revenues are used only to finance public investment in infrastructure (see, Glomm and Ravikumar, 1997).

In contrast to the above mentioned long-run dynamic models operating with private and public capital, the model developed below belongs to the so-called short-run models. It analyzes the situation when a certain government policy focuses to move the economy on a more productive stage. Usually, such a situation is characterized by the unbalanced government budget, significant debt and unemployment. As indicated earlier, this situation is currently in the U.S. and some European countries. Since the opinion of economists, mostly only supported by chosen historic examples, diverges whether government spending focused on infrastructure can improve the economic situation, the developed debt to GDP ratio dynamics model focuses to resolve this problem rigorously.

The debt to GDP ratio d_t dynamics can be presented as

$$d_{t+1} - d_t = \frac{D_{t+1}}{Y_{t+1}} - \frac{D_t}{Y_t} = \frac{D_t + rD_t + G_{t+1} - T_{t+1}}{Y_t(1+\mathrm{g})} - \frac{D_t}{Y_t} = \frac{r-\mathrm{g}}{1+\mathrm{g}} d_t + \frac{G_{t+1} - T_{t+1}}{Y_{t+1}} \tag{4}$$

where

$$Y_{t+1} - Y_t = A\left(K_t^{\alpha} + \alpha K_t^{\alpha-1}\dot{K}_t\right)(L_t^{\beta} + \beta L_t^{\beta-1}\dot{L}_t) - AK_t^{\alpha}L_t^{\beta}$$

$$= (\alpha\frac{\dot{K}_t}{K_t} + \beta\frac{\dot{L}_t}{L_t} + O(\varepsilon))\,Y_t = \mathrm{g}\,Y_t \tag{5}$$

$$\mathrm{g} \approx \alpha\frac{\dot{K}_t}{K_t} + \beta\frac{\dot{L}_t}{L_t} \tag{6}$$

g is a GDP growth rate (we neglect O(ε) = $\alpha\beta\dot{K}_t\dot{L}_t / (K_tL_t)$, which has higher order of smallness than other terms of (5)).

Practical application of (4) requires knowledge of G_{t+1} and Y_{t+1}. However, these parameters are interconnected. In reality, we deal with a system of equations since Y_{t+1} depends on $\dot{K}_t$ and $\dot{L}_t$ (see (5) and (6)) and (4) should be supplemented with equations describing dynamics of capital K and labor L. Analysis of such a system presents substantial difficulties, especially when it is necessary to predict future values of the debt to GDP ratio. Below we use (4) to build the model that allows us to obtain the analytical solution of the lower estimate of d_t.

Let for $t = t_0$, $\mathrm{g} = \mathrm{g}_0 < r$, and $G_t = l_0T_t$, $l_0 > 1$ (l_0 characterizes the ratio between government expenditure excluding interest payments on the debt and its revenues, so that $l_0 > 1$ assumes the revenues to be less than the expenditures).

As indicated above, one of the approaches to stimulate GDP growth and employment is the use of additional government spending $\Delta\mathrm{G}_t$ to resuscitate the economy by investing in infrastructure – repair and build roads, bridges, etc. It is assumed that with the increasing number of working people the consumption will rise and this will stimulate economic growth. This approach was tested in a case of economic recessions – significant decline in the economic activity and high unemployment – and is recommended by many economists as the necessary cure for the economic slump. The multiple effect of infrastructure spending will be presented by the multiplier $l_1 > 1$.

A classic question in macroeconomics about the size of the government spending multiplier was extensively discussed in economics literature (e.g., Auerbach and Gorodnichenko, 2010; Blanchard and Perotti, 2002; Christiano et al., 2011; Leeper et al., 2010; Ramey, 2011). Numerical estimates of the value of the fiscal multiplier vary significantly across model classes. Within each class of models, they vary a lot with the economic and policy environment. Using traditional macroeconomic models Christiano et al. (2011) under rather rigorous assumptions show that the multiplier varies enormously

depending on how monetary policy reacts to the economy. They found the long-run effect to be positive and the multiplier can be as high as about 4. However, in most of the related publications the multiplier's peak value does not exceed 2.5. The results of some researchers differ significantly since the theoretical models used to examine the impact of government spending on GDP contain many interconnected parameters which cannot be determined precisely. Some results based on econometric models (e.g., Auerbach and Gorodnichenko, 2010; Blanchard and Perotti, 2002; Ramey, 2011) cannot be reproduced in the Neo-Keynesian models. Auerbach and Gorodnichenko (2010) found that in recessions the long-run multiplier's effect is as high as 2.5 but as low as –1 in expansions.

Although the mentioned publications analyze the multiplier's dynamics, usually in practice, in simulation models, the multiplier is presented as a constant parameter. Since additional government spending contributes to the national debt, it is of importance to determine whether the projected future economic growth (in accordance with a chosen multiplier) is sustained with the resulting national debt.

The model analyzed below corresponds to the case of declining economic activity, substantial debt and high unemployment. It is assumed that at $t = t_0$, $\dot{L}_{t_0} = 0$ and for $t > t_0$, when the government stimulus package focuses infrastructure, the GDP growth the rate $g_1 > g_0$ can be achieved by increasing employment, i.e., in (6) for $t > t_0$, $\dot{L}_t > 0$.

For simplicity, we consider the initial moment $t_0 = 0$, so that $t = 0,1,2,\ldots$.

Assuming that the taxes remain unchanged, the additional government spending ΔG_{t+1} at $t \geq t_0$ to increase Y_t and make it growing with the rate $g_1 > g_0$, i.e.,

$$Y_{t+1} = (1 + \mathrm{g}_1) Y_t \ , \tag{7}$$

should be

$$\Delta G_{t+1} = l_1^{-1}[(\mathrm{g}_1 + 1)^{t+1} - (\mathrm{g}_0 + 1)^{t+1}]Y_0 \tag{8}$$

(the above equation follows directly from the definition of the fiscal multiplier).

The assumption that the rate change is implemented immediately, i.e., the government spending takes effect without delay, which usually contradicts reality (inevitable delays may produce even opposite effect) will allow us to consider the obtained debt to GDP ratio estimate as optimistic. In addition, we assume that the basic government spending $G_t = l_0 T_t = l_0 \tau Y_t$ is not only frozen at $t = t_0$ (as a percent of GDP; see (2)) but for $t > t_0$ it will decrease by $\Delta G_{1,t+1}$ due to the increase in employment

$$\Delta G_{1,t+1} = l_2 (e^{\frac{\mathrm{g}_1 - \mathrm{g}_0}{\beta}(t+1)} - 1) G_0 \tag{9}$$

where l_2 characterizes the percent of welfare related spending at $t = t_0$; the exponential term reflects the step g-rate change in (6), and to simplify the model we ignore the influence of the capital component in (6) and operate with the increased rate of employment $(\mathrm{g}_1 - \mathrm{g}_0)\beta^{-1}$ (this simplification, as well as mentioned earlier, gives an optimistic estimate of the debt to GDP ratio; in (6) L and K are continuous variables).

Based on (7)-(9), the model describing the debt to ratio dynamics under the government strategy to decrease unemployment ($\dot{L} > 0$) and boost the economy (increase the growth rate from g_0 to g_1) by investing in infrastructure has the form

$$d_{t+1} = \left(1 + \frac{r - g_1}{1 + g_1}\right) d_t +$$

$$+ \frac{G_0 - l_2(e^{\frac{g_1 - g_0}{\beta}(t+1)} - 1)G_0 + l_1^{-1}[(g_1 + 1)^{t+1} - (g_0 + 1)^{t+1}]Y_0}{(1 + g_1)^{t+1} Y_0} - \tau$$

$$t = 0,1,2,\ldots \tag{10}$$

or since (see (7) and (9)) $G_0 = l_0 T_0 = l_0 \tau Y_0 = l_3 Y_0$, where $l_3 = l_0 \tau$, the above equation can be transformed to

$$d_{t+1} = \left(1 + \frac{r - g_1}{1 + g_1}\right) d_t + \frac{l_3 - l_2 l_3 (e^{\frac{g_1 - g_0}{\beta}(t+1)} - 1) + l_1^{-1}[(g_1 + 1)^{t+1} - (g_0 + 1)^{t+1}]}{(1 + g_1)^{t+1}} - \tau$$

$$t = 0,1,2,\ldots \tag{11}$$

Since the employment growth rate in the considered model is $(g_1 - g_0)\beta^{-1}$ (see (9)), it is valid only for a finite time interval. Taking into account the population growth, the current and admissible levels of unemployment, as well as reasonable values of g_1 and g_0 it is easy to conclude that the results obtained from the analysis of (11) are valid for the time interval of approximately 10-15 years.

The equation (11) is a recursion formula that specifies a recursive procedure for determining d_{t+1} based on d_t , $t = 0,1,2,\ldots$

Although the solution of (11) is given for a constant tax rate τ , in reality τ depends on time. But in the case of the unchanged government tax policy and absence of sharp economic turns the τ –changes are small. For example, the U.S tax revenues have averaged about 18.3 percent of GDP over 1970-2008. In 2009, it dropped to 15.1 percent and grew slowly to 15.8 percent in 2012. Since we operate with the lower estimate of the debt to GDP ratio, in the below examples τ is chosen to satisfy this requirement.

3. Simulation Results

The below examples are given for several fiscal multipliers examined in the literature (e.g., Auerbach and Gorodnichenko, 2010; Blanchard and Perotti, 2002; Christiano et al., 2011; Leeper et al., 2010; Ramey, 2011).

Table 1 presents the debt to GDP ratio estimate for the 10 years period based on the solution of (11) for the following parameters: $d_0 = 1$; r = 0.0289; $\tau = 0.14$; $\beta = 0.75$; $l_0 = 1.7$; $l_2 = 0.1$ (they are very close to the data characterizing the current state the U.S. economy). The table is built for g_0=0.02, g_1=0.03, and g_0=0.02, g_1=0.04,respectively. The chosen multiplier $l_1 = 1.59$ is recommended by Mark Zandi, chief economist of Moody's Analytics. As seen from Table 1, for the considered multiplier the debt to GDP ratio increasesal most twice in 10 years for g_1=0.03 and g_1=0.04.

Table 1: Simulation results for the considered debt to GDP ratio dynamics model for l_1 = 1.59

year	1	2	3	4	5	6	7	8	9	10
debt/GDP g_1=0.03	1.109	1.190	1.284	1.377	1.47	1.561	1.653	1.744	1.835	1.926
debt/GDP g_1=0.04	1.089	1.181	1.273	1.368	1.464	1.563	1.663	1.765	1.870	1.977

Since this and similarmultiplier's values are not supported by rigorous mathematics and their validity is argued by many economists, in Table 2 we presented the debt to GDP ratio estimate for $l_1 = 3.8$, the value given in Christiano et al. (2011). As seen from Table 1 and Table 2, the lower values of d_t correspond to the multiplier with the higher value.

Table 2: Simulation results for the considered debt to GDP ratio dynamics model for l_1 = 3.8

year	1	2	3	4	5	6	7	8	9	10
debt/GDP g_1=0.03	1.092	1.18	1.263	1.342	1.417	1.488	1.155	1.619	1.68	1.737
debt/GDP g_1=0.04	1.082	1.16	1.232	1.3	1.363	1.422	1.478	1.529	1.578	1.623

Of course, the GDP growth rate g_1 depends not only on the level of government investment in infrastructure. It depends on many factors including tax policies and the state of the world economy. Some economists - advocates of stimulus packages - prefer to ignore these factors and attribute economic growth only to stimulus measures. Taking into account that since the second quarter of 2000 the U.S. GDP rate has never reached the 5 percent level, we consider also the rosy scenario and evaluate the debt to GDP ratio for g_1=0.05 and l_1=3.8. The results presented in Table 3 show that even for this case in 10 years the debt

to GDP ratio would increase by more than 50 percent. The reason of inefficiency of the described stimulus policy is a very high (100% of GDP) initial debt and a high level of the federal government spending (24% of GDP).

Table 3: Simulation results for the considered debt to GDP ratio dynamics model for $l_1 = 3.8$

year	1	2	3	4	5	6	7	8	9	10
debt/GDP g_1=0.05	1.073	1.14	1.202	1.259	1.312	1.36	1.405	1.446	1.484	1.52

The above considered model assumes that the government financial policy (excluding investment in infrastructure) remains unchanged, and as it follows from data of Table 1 and Table 2 the debt to GDP ratio increases with time. To analyze the efficiency of the policy combining investment in infrastructure with decreasing other government spending we assume that government spending not related to infrastructure decreases with a rate h, i.e., instead of the term G_0 in (10) we have G_t that is the solution of the equation

$$G_{t+1} = (1-h)^{t+1} G_t, \; t = 0,1,2,\ldots \tag{12}$$

so that the modified equations (10) and (11) should have instead of the terms G_0 and l_3 the terms $(1-h)^{t+1} G_0$ and $(1-h)^{t+1} l_3$, respectively.

Table 4 and Table 5 contain the simulation results for this case; h = 0.02 is chosen to get about a 20% decrease in the government spending in 10 years. As expected, the debt to GDP ratio estimate is less than in Table 1 and Table 2. However, the debt to GDP ratio is still above its initial value.

Finally, we consider the situation that at $t > t_0$ the government fiscal policy results in a conditionally balanced budget (revenues equal expenditure, excluding payments on infrastructure spending).

This corresponds to $\left(1+g_1\right)^{-(t+1)} l_3 - \tau = 0$ and r = 0 in (11). The simulation results in Table 6 show that the balanced budget is a proper approach to decrease the debt to GDP ratio, andgovernment spending on infrastructure may lead to a declining debt to GDP ratio when a balanced budget approach is followed at the same time. The data in Table 6 allows us to assume(since the considered model deals with a lower estimate, rather than the real value, of the debt to GDP ratio) that extensive infrastructure spending to increase significantly the GDP rate (in 10 years for g_1=0.04 the lower estimate of d_t equals 0.883) can be less effective, with respect to the debt to GDP ratio, than in the case of a moderate GDP growth (for g_1=0.03 this estimate equals 0.855).

Table 4: Simulation results for the considered debt to GDP ratio dynamics model for $l_1 = 1.59$

year	1	2	3	4	5	6	7	8	9	10
debt/GDP g_1=0.03	1.091	1.177	1.258	1.335	1.407	1.476	1.542	1.606	1.666	1.725
debt/GDP g_1=0.04	1.085	1.167	1.248	1.327	1.405	1.482	1.56	1.637	1.716	1.795

Table 5: Simulation results for the considered debt to GDP ratio dynamics model for $l_1 = 3.8$

year	1	2	3	4	5	6	7	8	9	10
debt/GDP g_1=0.03	1.111	1.203	1.277	1.333	1.373	1.396	1.405	1.399	1.379	1.347
debt/GDP g_1=0.04	1.078	1.147	1.206	1.259	1.304	1.342	1.374	1.401	1.423	1.441

Table 6: Simulation results for the considered debt to GDP ratio dynamics model for $l_1 = 3.8$ and the conditionally balanced budget assumption

year	1	2	3	4	5	6	7	8	9	10
debt/GDP g_1=0.03	0.973	0.949	0.928	0.91	0.895	0.882	0.872	0.864	0.858	0.855
debt/GDP g_1=0.04	0.966	0.937	0.915	0.897	0.884	0.875	0.872	0.872	0.876	0.883

The Cobb-Douglas function (3) is considered for a constant A, i.e., it is assumed that a period of economic downturn is not accompanied with technological innovation that can ignite economic and job growth. For example, at the end of 20th century the Internet and information technology became accelerators of the economy in many countries. In the late 1990s, the U.S. government moved into fiscal surplus and the debt to GDP ratio fell from 66% in 1995 to 56% in 2000. However, it is too risky to spend lavishly on infrastructure with a hope of Internet-type miracles in the future.

The above analysis shows that government investment in infrastructure alone cannot decrease the debt to GDP ratio and boost the economy. It shows that Krugman, as well as

some other economists, are wrong in their belief that the ratio of debt to GDP will fall and "everything worked out fiscally". But Krugman is right by saying "increasing government debt can increase growth, if the money is invested well". Public-private partnerships, individual and corporate contributions to infrastructure financing are innovative ways to seek new funding mechanism in order to prevent deficits from rising. To boost the economy, investment should focus on areas which would bring a substantial profit and growth of capital, i.e., $\dot{K} > 0$ in (6). Government stimulus programs related to these areas can increase growth and decrease the debt to GDP ratio. However, usually, the private sector (less bureaucratic and more dynamic than the public one) is more sophisticated and faster than the government in finding and investing in such areas.

As mentioned earlier, the existing publications focus mostly on investigating how efficient investment in infrastructure is and how dangerous high debt to GDP ratios are for economic growth, more precisely, how they influence the GDP growth rate (see also Beyzatlar and Kustepeli, 2011; Ichoku et al., 2012). The above simulation results show that economic growth reached by government investment in infrastructure can increase its debt to such a degree that the debt to GDP ratio becomes dangerously high. The crises in Greece and Ireland show the consequences of high debt to GDP ratios for countries with previously fast growing economies.

4. Conclusion

The developed debt to GDP ratio dynamics model belongs to the so-called short-run models. It analyzes whether government spending focused on infrastructure can improve the economic situation and whether this government fiscal policy is an effective tool in boosting the economy in times of economic downturn. The paper is a useful addition to the debate: is it best to let debt increase in the hope of stimulating economic growth to get out of the slump or is it better to cut spending to get public debt under control? The simulation results based on the developed debt to GDP ratio dynamics model for the data characterizing the current state of the U.S. economy show that government investment in infrastructure alone cannot decrease the debt to GDP ratio. Programs like public-private partnerships, individual and corporate contributions to finance infrastructure projects are potential mechanisms through which public spending on infrastructure can be more efficient. Government spending on infrastructure may lead to a declining debt to GDP ratio when a balanced budget approach is followed at the same time.Only investment in the areas which would bring a substantial profit and growth of capital can increase growth and decrease the debt to GDP ratio. Reforms to encourage private investment are the proper financial policies to restore economic health.

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Investigating the Influence of Economic and Socio-Political Openness on Growth

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Abstract

This paper investigates the influence of international openness on economic growth in a sample of 32 European economies. The usual approach in the literature on the topic is to observe the impact of trade openness on growth. We, however, broaden this standard approach and analyse not only economic aspect of openness but also socio-political aspect. In our empirical analysis we use the TSLS (two stage least squares) estimator, whereby in the first step we use the standard growth regression that includes, among other variables, openness, and in the second step we include different determinants to instrument openness. Our research, in general, shows that openness is an important determinant of growth in a set of investigated countries. Trade openness and financial openness influence growth positively. The influence of institutions on growth is manifested mainly indirectly – through its influence on trade and financial openness.

Keywords: openness, growth, EU, institutions

JEL Classification: F43, C26, O4

1. Introduction

The main goal of this paper is to empirically investigate the influence of international openness on growth in a sample of 32 European economies (15 old EU members, 12 new EU members and five prospective EU members from the Balkans – Croatia, Bosnia and Herzegovina, F.Y.R.O.M., Serbia and Albania). All of the countries in the sample are enganged in the process of European integration, albeit at different stages.

The usual approach in the literature on the topic is to observe the impact of trade openness on growth, whereas we adopt a broader approach and analyse not only the economic aspect of openness (trade and financial openness) but also socio-political one. This paper, thus, represents a unique attempt to identify the impact of openness on

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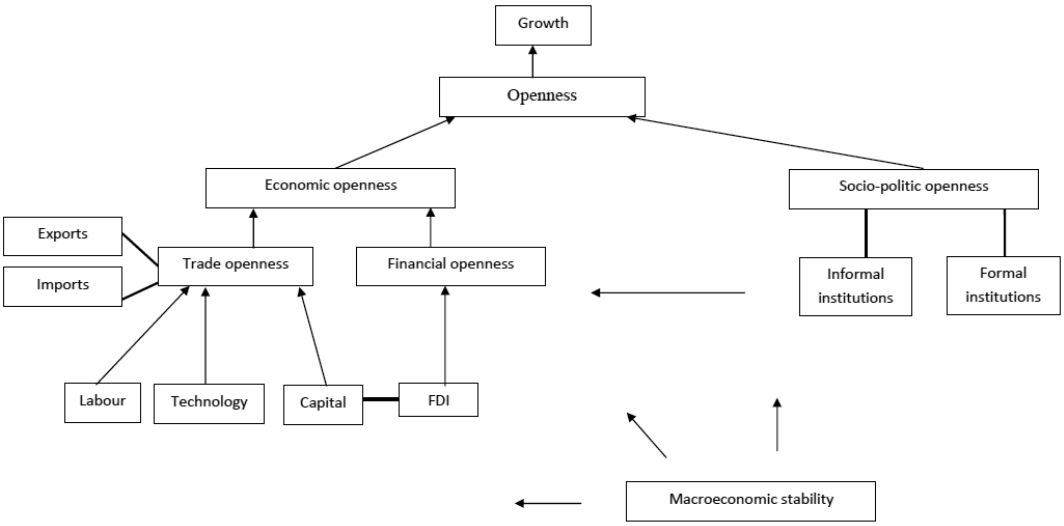
growth from a broader perspective. In doing so we first present theoretical background by identifying the channels through which various aspects of openness may be impacting growth, and take particular care of the potential inter connectedness between these different aspects. The identified theoretical links are then investigated empirically, using the two stage least squares estimator, whereby the model is evaluated in two steps. In the first one the influence of openness on growth is analysed through the standard growth regression, whereas in the second step we instrument openness by different variables and estimate their impact. It should be stressed that, in order to account for different aspects of openness, various indicators are used for proxying openness, such as the share of exports plus imports in GDP (a measure of trade openness), FDI per capita (which measures financial openness), Voice and accountability indicator from Worldwide Governance indicators (which serves as a proxy for formal aspect of institutional openness), and an indicator constructed from the data taken from World Values Survey (which serves as a proxy for informal aspect of institutional openness).

The paper is structured as follows. Section 2 provides theoretical background linking different aspects of openness and growth. Section 3 presents the modelling strategy, variable selection and the main results from the empirical investigation. Section 4 concludes.

2. Theoretical background

International openness can be defined as the extent of barriers to the free movement of ideas, goods and services and factors of production between countries. International openness can have an effect on economic growth insofar as these barriers affect incentives to innovate, affect the underlying productivity of that innovation, the dissemination of research discoveries across national boundaries, the allocation of resources between research and current production etc. (Cameron, Proudman and Redding, 1999). Given the above definition of international openness, openness need not necessarily be viewed narrowly - as trade openness, but could also refer to financial openness (as measured by foreign direct investment, FDI), particularly having in mind that trade and FDI are basically two ways of servicing foreign markets, and that they are already interlinked in a variety of ways. Namely, financial capital, in particular FDI flows, can also influence economic growth in the sense of facilitating spillovers of ideas across countries. Moreover, institutions also fit the above definition insofar as they serve in eliminating barriers to free movement of ideas, goods and services and factors of production. This is presented in the upper part of Diagram 1.

Diagram 1: Schematic presentation of the impact of openness and its determinants on growth



Next we briefly discuss the mechanisms through which trade, financial and institutional openness influence growth.

The theoretical literature on the relationship between trade and growth started growing with the development of theories of endogenous growth (Romer, 1986; Lucas, 1988; Grossman and Helpman, 1991). A number of papers provide evidence that trade has a positive impact on growth (see, for example, Grossman and Helpman, 1991; Romer, 1990; Rivera-Batiz and Romer, 1991; Dollar and Kraay, 2002). The mechanisms through which this impact takes place are various. Namely, trade encourages growth through providing access to a larger market (hence giving greater incentives to deliver new inventions); through increased productivity (productivity can be raised by learning from new goods produced abroad); by helping prevent the duplication of research efforts across countries, by providing access to investment, intermediate goods and new products etc. Majority of the literature documents a positive impact of trade on growth (see, for example, Frankel and Romer, 1999). However, it should also be stressed that a number of studies takes a sceptical view of this positive impact (see, for example Rodriguez and Rodrik, 1999).

The impact of financial openness is usually investigated through FDI flows. The literature does not provide a unison answer regarding the impact of FDI on growth. On the one side, FDI enables positive externalities through diffusion of new technologies and know-how. Given that this diffusion has significant spillover effects, FDI not only affects the productivity in the sectors attracting FDI, but also indirectly results in an increase in productivity in the whole economy (Rappaport, 2000; de Vita and Kyaw, 2009). FDI also enhances competitiveness and enables scale economy effects for local producers. On the other side, some authors suggest that in presence of the existing trade, prices, financial and

other distortions, FDI actually hurts the allocation of resources and slows down economic growth (Brecher and Diaz-Alejandro, 1977; Brecher, 1983; Boyd and Smith, 1992; Carkovic and Levine, 2002).

On the right-hand side of Diagram 1 we consider the impact of socio-political openness (measured by formal and informal institutions) on growth. While rarely applied in this type of investigation, our focus on this aspect of openness rests upon the increasing relevance of institutions for growth as recognised by vast economic literature (North, 1991; Acemoglu, Johnson and Robinson, 2004; Rodrik, Subramanian and Trebbi, 2004; Frey and Steiner, 2012). Institutions, generally defined as "constraints that human beings impose on themselves" (North, 1990), prohibit, permit or require specific type of action that are important for different aspects of openness (e.g. reducing transaction costs, for improving information flows and for defining and enforcing property rights, Jutting, 2003). The impact of institutional openness on growth, however, is not as straightforward as was the case with the preceeding two types of openness. Namely, the influence of institutions on growth is usually understood as the influence of institutional quality on growth. Here we argue that institutional openness, defined as a situation where civil and political rights are respected, also affects economic performance. As noted by Powell (2000), institutional openness encompasses how easy it is to contact the elected representatives from within the system. It therefore shapes how effective an action is for influencing political decisions and consequently economic outcomes. Institutional openness can, therefore, be simply understood as an individual freedom. In line with this Harms and Ursprung (2002) indicate that individual freedom can influence growth positively or negatively, depending on whether the negative effect working through increased political contestability of income and wealth outweighs the positive effect working through more efficient monitoring of politicians, bureaucrats and rent-seekers. Additionally, as put forward by Rodrik (1999), external shocks have long-term adverse effects on growth in societies that lack the institutional capacity to respond to them properly. More precisely, strong institutions of conflict management (proxied by indicators of the quality of governmental institutions, rule of law, democratic rights, and social safety nets) are needed to deal adequately with external shocks. More open economies are assumed to experience greater exposure to these shocks, which can, in turn, unleash social conflict that generates uncertainty harmful to economic growth. The proper structure of decision process (institutional openness) is, hence, required to reap growth benefits of economic openness and to stress the influence of institutions on external environment. Considering the complexity of the institutional openness definition, we focus on formal and informal dimension of institutional openness. Following Amin (1999) formal dimension is represented by rules, laws and organisations, and informal by habits of individuals, social norms and values.

The approach we adopt, as outlined in Diagram 1, is, hence, consistent with endogenous growth theories in that we investigate the impact of openness on growth, and differs from the mainstream approach in that we assess this openness in various ways. We have, thus far, presumed that openness influences growth. There are, however, reasons to believe that causality actually goes the other way - from growth to openness (see, for

example Frankel and Romer, 1999). In the empirical part of the paper we implement the instrumental variable approach to avoid this reverse causality problem. The lower part of Diagram 1, therefore, refers to potential variables used to instrument openness. We explain these links next, starting from the left part of the Diagram and moving to the right.

Trade openness can be analysed through the main determinants of aggregate supply: labour, capital and technology.

Labour influences openness through the impact of productivity on international trade. Namely, more productive labour force is expected to result in domestic products being more competitive in international markets, and this, in turn, increases trade (e.g. Grossman and Helpman, 1991). Furthermore, productivity improvements due to intra-industry or intra-firm resource reallocation (Melitz, 2003; Bernard, Redding and Schott, 2007) are also likely to stimulate growth. However, although many studies present reasons for increased productivity attributable to openness (correction of failures of resource allocation under protective policies, promotion of technical progress, increase of productive efficiency (Liu and Nishijima, 2012)), the heterogeneous firm literature offers a rationale as to why this influence need not always be positive. It suggests that the lack of knowledge regarding export markets and regulations in other countries could obstruct positive relation between productivity and openness (Lejour et al., 2009), thereby explaining why researchers are often not able to find the permanent positive effect (Nordas, Miroudot and Kowalski, 2006).

The main channel through which technology influences growth is international spillover of knowledge and investments in innovation, as established in a number of theoretical and empirical studies (Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991; Keller, 1996; Aghion and Howitt, 1998). Namely, technological spillovers result in increased labour productivity in the recipient country, higher production of new ideas and new applications in research and development (RandD). This increases RandD effectiveness, which stimulates economic growth because new technologies promote more efficient methods of production with a given amount of labour and capital. On the other hand, as argued by Stokey (1995) and Jones and Williams (2000), alongside positive externalities in the RandD process, there is also a possibility of some negative externalities, which makes the empirical assessment of the RandD contribution very doubtful (Pessoa, 2007).

The impact of capital on openness and, consequently, growth is investigated through the FDI. The impact of FDI is, therefore, investigated both indirectly (through its impact on international trade) and directly (through its impact on growth). The latter was explained before; hence here we explain only the former. The linkages between FDI and trade are complex, depending on whether FDI is considered to be a substitute (see, for example, Markusen, 1984) or a complement (see, for example, Helpman, 1984) to international trade. When a company decides to set up a foreign plant, it reduces its exports of goods to that market, which affects trade negatively. Trade and FDI are, in this case, substitutes. If, on the other hand, a company divides various production stages across different countries to take advantage of lower factor prices, FDI and trade will act as complements, and trade would, consequently, increase. Furthermore, the direction of causality between the two also

raises questions. As noted by Liu, Wang and Wei (2001), the existing literature suggests that many firms in manufacturing still follow the traditional gradual sequence of servicing foreign markets: first they trade in a foreign market (since trade is easier and less risky than FDI), and afterwards (after learning more about the economic, political, and social conditions and gaining more experience) they establish producing subsidiaries in the foreign market, which may, later on, begin to export.

Finally, the right-hand side of Diagram 1 assesses the influence of formal and informal institutions on growth. We have already explained the direct link between institutional openness and growth, but the fact that institutional factors affect trade and FDI openness should also be taken into account. Namely, weak growth gains from trade openness can often be explained by the lack of effective institutions. In particular, due to ineffective institutions, the gains from trade expansion need not be translated into economic diversification and growth. Inefficient institutional framework of the financial system may also explain weak transmission from trade openness to growth (Baliamoune-Lutz and Ndikumana, 2007). Empirical research by Dollar and Kraay (2002) suggests that good institutions are critical for the ability of a country to generate long-run growth gains from trade openness. Moreover, FDI flows, used as an indicator of financial openness can also be affected by different aspects of institutions. Good institutional environment can enhance investment in technology by effective patent protection (Andersen and Babula, 2008). Busse and Hefeker (2007), for example, find that different aspect of institutional quality (e.g. government stability, less internal and external conflict, less corruption, a lower level of ethnic tensions, higher levels of law and order, more democratic accountability, and the quality of the bureaucracy) have a positive and significant impact on FDI inflows.

So far we have outlined the links between different aspects of openness and growth (Diagram 1). In what follows we test these links empirically.

3. Empirical investigation

In this section of the paper we investigate the impact of different aspects of openness on growth, as well as the determinants of trade and financial openness. The analysis is conducted using a sample of 32 European economies (15 old EU members, 12 new EU members and five prospective EU members from the Balkans – Croatia, Bosnia and Herzegovina, F.Y.R.O.M., Serbia and Albania, i.e. EU27+5Balkan). This study represents a unique attempt to test the impact of openness on growth in a sample of countries engaged in a process of economic and political integration in Europe. Within this we distinguish between old members (EU15), new members (EU12), the whole of EU (EU27) and the full sample (EU27+5Balkan).

3.1 Variable selection

Selection of the variables follows Diagram 1. All the selected variables are explained below.

Given the complexity of the institutional openness definition we use two different proxies, one for formal and one for informal dimension. For informal institutions we follow Tabellini (2007) and use the results from World Values Survey as a proxy for social openness. More precisely, we use the answers to the following questions:

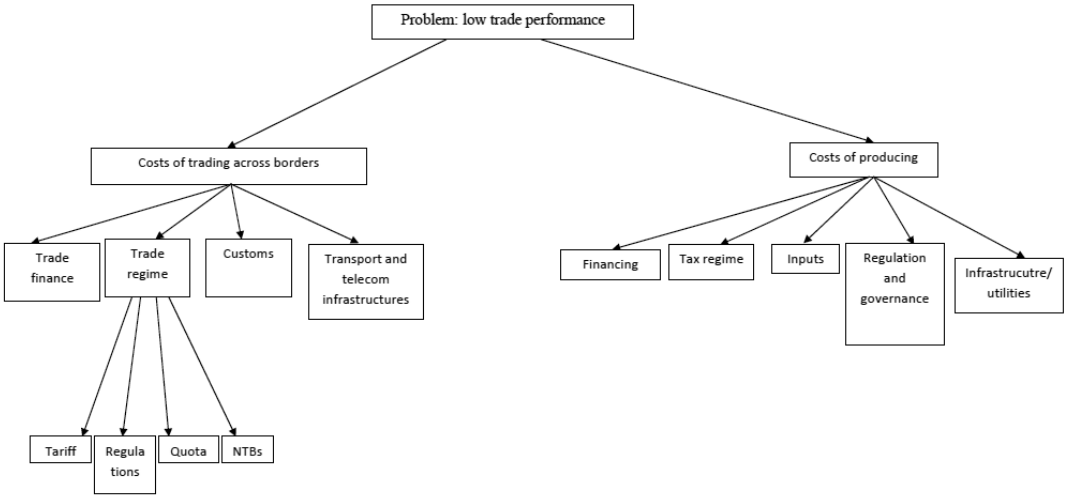
- A035. - Here is a list of qualities that children can be encouraged to learn at home. Which, if any, do you consider to be especially important? Please choose up to five.
- A129 - On this list are various groups of people. Could you please sort out any that you would not like to have as neighbours?
- C002 - When jobs are scarce, employers should give priority to (nation) people over immigrants.

Our proxy (WVS) is then created by combining the answers to these questions, so that we use the percentage of people whose answer to question 1 (A035) was: Tolerance and respect for other people, the percentage of people that did not mention: Immigrants, in answering question 2 (A129) and the percentage of people that did not agree with the third question (C002).

The formal aspect is measured by the Worldwide Governance Indicator (WGI) (Kaufmann, Kraay and Mastruzzi, 2010). The WGI is a long-standing research project to develop cross-country indicators of governance. It consists of six composite indicators of broad dimensions of governance covering: Voice and Accountability (VA), Political Stability and Absence of Violence/Terrorism (PS), Government Effectiveness (GE), Regulatory Quality (RQ), Rule of Law (RL), and Control of Corruption (CC). In our empirical analysis we will use WGI as an instrument for measuring the indirect impact of institutions on growth (through its influence on trade and financial openness). The composite indicator Voice and Accountability will be used as a measure of the direct influence of institutional openness on growth. This indicator is defined as perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. These aspects are considered as good representatives of institutional openness, given the theoretical discussion and definition presented in Section 2.

As indicated earlier, the literature that investigates how openness affects growth tipically focuses on international trade only. Therefore, in the next step we consider the segment of international trade in more detail, as presented in Diagram 2 below.

Diagram 2: Growth diagnostics adjusted for trade



Source: Hallaert and Munro (2009), Figure 3, p. 25

Our starting point for the analysis of international trade is the decision tree taken from Hallaert and Munro (2009), who adjusted the growth diagnostics approach for a more detailed investigation of trade. Diagram 2 identifies, as the main constraints to trade expansion, the following: financing of trade and production, trade regime, trade customs/ habits, traffic and other infrastructure, tax regime, inputs and rules and governance. However, if we want to empirically test the above-identified links, the unavailability of the data appears as an immediate problem. Therefore, in order to reduce the choice of variables dictated by Diagram 2, we cross-referenced them with the data from Enterprise Survey (reported by the World Bank), and used only those variables that are recognised by the exporters and investors as the most constraining ones for doing business. More precisely, from Enterprise Survey we collected the data on the number of firms in each of the countries in our sample (for which the data were available) that indicated the main obstacles to doing business. After averaging the data across countries, we ranked constraints from the largest to the smallest. This procedure resulted in recognition of the following main obstacles to trade and investment: Access to finance, Inadequately educated labour force, Political instability, Practices of the informal sector, Corruption and Customs and trade regulations. These obstacles dictate our choice of variables which will be used as determinants of openness. Accordingly, we use the following:

- Access to finance is measured by variable Private credits (PRIV_CRED), which stands for the amount of loans provided by banks and other financial institutions to private sector, expressed as a percentage of GDP. The data are obtained from Database on Financial Development and Structure, compiled by Beck, Demigurc-Kunt and Levine (2010).

- Corruption, as well as trade regime and customs duties are covered by the variable WGI, which accounts for the impact of formal institutions. Namely, since, as explained earlier, WGI contains the indicator CC (which refers to the control of corruption), as well as the indicator RQ (which refers to regulatory quality), the inclusion of individual indicators for corruption and trade regime and customs duties would result in multicollinearity. Inclusion of custom duties as an individual variable would be also impractical as this variable varies very little. Namely, in EU27 countries all the customs duties are unified, and in consequence, the only source of variability would be due to the five EU non-members in our sample.
- The informal sector is also contained in variable WGI. Namely, informal dimension, defined by habits of individual social norms and values (Amin, 1999) can be recognised in several WGI componenets: VA captures perceptions of the extent to which a country's citizens are able to participate in selecting their governments as well as freedom of expression, freedom of association and a free media, while PS measures perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.
- Adequacy of education of work force is accounted for by the variable EDU, which stands for the rate of high school enrolment. This rate is calculated as a share of all enroled in high school in total population of the relevant age group which officially corresponds to that level of education. The data are obtained from World Development Indicators.
- Political/macroeconomic (in)stability is accounted for by including the real effective exchange rate (REER), which is obtained from the World Development Indicators, and expressed as an index based in 2005.

The labour dimension of trade openness is proxied by productivity (PROD), defined as productivity of labor per employed person (US$, 2010). We use the data from The Conference Board Total Economy Database, January 2011, available at http://www.conference-board.org/data/economydatabase.

Technological development is measured by the share of research and development (RandD) expenditures in GDP, obtained from World Development Indicators.

As for FDI, they are measured in per capita terms and in US$. The data are available from World Development Indicators.

In addition, we include the Herfindahl-Hirschman (HH) index to account for the impact of export concentration. Namely, as argued by Rodrik (1998), countries that export only a few commodities are presumably more exposed to external risk than countires with a diversified set of exports. The HH index is calculated as a sum of squares of exports of each product in total exports. The data are obtained from the UN Commodity Trade Statistics Database (UN Comtrade), and the used nomenclature is SITC 1: 3 digit. Thus, we have accounted for all the important factors which might arise as constraints of openness and which were suggested by Diagram 2 and the Enterprise Survey.

The variables that we will also need in our analysis are the variables of growth regression (see explanation in Section 3.2) and these are growth rate of GDP per capita (ΔGDP), GDP per capita in the initial period (GDP_{t0} - usually this variable is in empirical studies replaced by variable GDPgap (because in panel data the initial GDP per capita does not vary), which we calculate as a share of GDP per capita of a country in the average GDP per capita in EU27 countries), population growth rate (POP) and investment rate (INV). The last variable is calculated as the share of gross investment in long term assets in GDP. All the mentioned data are obtained from the World Development Indicators.

3.2 Modelling approach

Since the goal of this paper is not just identification of the determinants of openness, but also growth as the ultimate objective, the starting point of our emipirical analysis is growth regression. The literature lists a large number of variables that may be included in this type of regressions. Our initial specification includes the basic determinants of the steady state, namely initial GDP level, investment rate, high school enrolment rate and population growth. This is in line with Levine and Renelt (1992) and Sala-i-Martin (1997) which are the two most significant studies investigating robustness of individual variables in growth regressions. While their approaches differ, they set the control variables, i.e. the variables that are included in all growth regressions, in a very similar way, and these variables are exactly the variables accounted for in growth regeression in the present study. In addition, given the aim of the present study, and in line with the endogenous theories of growth, we include also the variable OPENNESS, as presented in the equation below.

$$\Delta GDP_{it} = \alpha_0 + \alpha_1 GDP_{t0} + \alpha_2 OPENNESS_{it} + \alpha_3 INV_{it} + \alpha_4 POP_{it} + \alpha_5 EDU_{it} + w_{it} \quad (1)$$

where w stands for regression error, α are parameters to be estimated, *i* stands for a country and *t* for a period. Since there is a strong possibility that the link between openness and growth goes also in the other direction (endogeneity problem) we treat this issue by using the TSLS (two stage least squares) estimator, i.e. by estimating the model in two steps. Therefore, in the second step we consider the determinants of openness, as presented in equation 2.

$$OPENNESS_{it} = W_{it}\delta + \varepsilon_{it} \quad (2)$$

$$W = \begin{bmatrix} PRIV\_CRED \\ WGI \\ HH \\ PRODUCTIVITY \\ REER \\ FDIpc \\ RandD \end{bmatrix} \quad (3)$$

$$OPENNESS = \begin{bmatrix} \frac{X+M}{GDP} \\ FDIpc \\ VA \\ WVS \end{bmatrix} \quad (4)$$

where W is a vector of variables that influence openness, δ are the parameters to be estimated and ε is the regression error. As can be seen in equation 3, we instrument openness with variables that we consider to be the main candidates for its determinants, as elaborated in Section 3.1. This selection of variables refers primarily to the determinants of trade openness (measured by the openness indicator (X+M)/GDP). However, since we want to keep the width of our approach and to account for all aspects of openness presented in Diagram 1, we use, as a measure of openness, different indicators (equation 4). These include: a share of exports and imports in GDP, FDI per capita, VA indicator and WVS indicator. We use the first indicator to estimate the impact of trade openness on growth, the next indicator measures the impact of financial openness and the following two indicators measure the impact of formal and informal dimension of institutional openness. Unlike trade openness, to account for determinants of financial openness (measured by FDIpc) we take into consideration WGI, PROD, REER and RandD. Finally, it should be noted that institutional openness (formal and informal) is not instrumented, because institutions are in the literature recognised as fundamental determinants of growth (Acemoglu, Johnson and Robinson, 2004). Therefore, in these cases the analysis is conducted in only one step – the growth regression, in which openness is measured by VA indicator for formal and WVS indicator for informal dimension of institutional openness. For easier understanding we outline our approach in Table 1 below.

Table 1: Choice of the openness measure and potential determinants of openness

	Measure of openness (OPENNESS)			
	(X+M)/GDP	**FDIpc**	**VA**	**WWS**
PRIV_CRED	√			
WGI	√	√		
HH	√			
PROD	√	√		
REER	√	√		
FDIpc	√			
R&D	√	√		

3.3 Results

The model that we estimate is explained in more detail in section 3.2, and here we only present the results of empirical analysis. As indicated before, in addition to estimating growth regression, we analyse how access to finance, institutional development, export concentration, productivity, foreign direct investment and research and development (technology) influence openness.

Because of potential endogeneity of regressors we use the TSLS estimator, which enables us to obtain consistent parameters. Namely, as discussed before, there is a possibility of reverse causality going from growth to (trade and financial) openness, and this should be taken into account. Indeed, our tests (not reported, but available upon request) suggest that trade and financial openness cannot be treated as exogenous (the null hypothesis of exogeneity is rejected). It is precisely for this reason that we adopt the instrumental variable approach whereby we instrument openness with a number of variables, as indicated by Equations 2 and 3. Tables 2-5 report results of our empirical estimations. The lower part of Tables 2 and 3 contains diagnostic tests that check the quality of chosen instruments[1]. Hansen J statistic is high in all specifications, indicating that the instruments are valid i.e. that our instrument set is appropriate (we have excluded variable PRIV_CRED from our anaylsis since the tests indicated that it was a bad instrument). In addition, Kleibergen-Paap rk LM and rk Wald statistic indicate that we can reject the null of underidentification. Kleibergen-Paap Wald rk F statistic, furthermore, rejects the null hypothesis that the instruments are weak. Moreover, the Anderson-Rubin Wald test and Stock-Wright LM test reject their null hypothesis and indicate that the endogenous regressors are jointly relevant.

In addition, since preliminary testing (Arellano-Bond test for autocorrelation and Pagan and Hall, Breusch-Pagan/Godfrey/Cook-Weisberg and White/Koenker tests of heteroskedasticity) indicated that there is a problem of autocorrelation and heteroscedasticity, all the results reported in Tables 2-5 contain heteroscedasticity and autocorrelation robust standard errors. In Tables 2-5, the results are reported for different groups of countries (EU27+5Balkan, EU27, EU15 and EU12). We use annual data for the period 1995-2009 and apply the two-stage-least-squares estimator. In addition we test whether these established empirical relationships prevail in the period 2005-2009 when the integration process in Europe formally embraced the countries from Central and Eastern Europe. We use Stata command *ivreg2*, which can be applied to both cross-section and panel data. Our data is organised in a panel, i.e. a cross-section of time series, which enables us to take advantage of the greater variation in the data, since variables vary in two dimensions.

[1] Since tests for assessing instrument validity and other related tests are not readily available in general econometric textbooks, we give additional explanations in the Appendix. The authors thank an anonimous referee for pointing this out.

Table 2: Openness variable: (X+M)/GDP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(X+M)/GDP	0.02*** (0.000)	0.01*** (0.000)	0.02*** (0.007)	0.02 (0.859)	0.01*** (0.010)	0.01*** (0.010)	0.01* (0.079)	-0.015 (0.217)
GDPgap	-0.39 (0.219)	-0.36 (0.437)	-0.43 (0.718)	-1.14 (0.458)	-0.81 (0.134)	-0.76 (0.264)	0.51 (0.758)	3.12 (0.209)
INV	0.17*** (0.003)	0.17** (0.027)	0.09 (0.282)	0.28*** (0.001)	0.17** (0.037)	0.19* (0.083)	0.16 (0.254)	0.40** (0.015)
POP	-1.45*** (0.000)	-1.49*** (0.000)	-1.09** (0.030)	-0.99 (0.393)	-1.60*** (0.001)	-1.66*** (0.003)	-1.49* (0.059)	-4.33** (0.037)
EDU	0.17 (0.915)	0.26 (0.893)	-0.68 (0.696)	10.72 (0.154)	-1.68 (0.628)	-2.34 (0.515)	-0.17 (0.943)	-7.85 (0.571)
WGI	39.70*** (0.006)	40.68*** (0.007)	41.79* (0.068)	10.52 (0.700)	91.00*** (0.000)	88.85*** (0.001)	30.01 (0.424)	49.59 (0.355)
HH	201.73** (0.017)	184.88** (0.030)	329.76 (0.101)	378.73*** (0.000)	217.29* (0.098)	206.33* (0.093)	674.92 (0.175)	437.40*** (0.000)
PROD	82.29*** (0.000)	71.78*** (0.009)	63.03 (0.128)	135.88** (0.024)	167.69*** (0.000)	157.36*** (0.001)	27.55 (0.675)	87.04 (0.509)
REER	-127.42*** (0.000)	-126.13*** (0.000)	92.92 (0.125)	-87.84** (0.022)	64.43 (0.394)	69.89 (0.451)	-12.70 (0.964)	46.37 (0.595)
FDIpc	23.39*** (0.000)	24.61*** (0.000)	19.25*** (0.000)	6.59 (0.290)	20.51*** (0.000)	21.81*** (0.000)	18.42*** (0.004)	4.16 (0.400)
R&D	-6.53 (0.205)	-9.33* (0.099)	-29.63*** (0.000)	25.86 (0.143)	-20.50** (0.020)	-25.11*** (0.005)	-39.05*** (0.000)	29.06 (0.220)
1995-2009	√	√	√	√				
2005-2009					√	√	√	√
EU27+5Balkan	√				√			
EU27		√				√		
EU15			√				√	
EU12				√				√
No. of obs.	210	196	127	69	87	82	54	28
Uncentered R2	0.9256	0.9249	0.9430	0.9698	0.9403	0.9451	0.9505	0.9872
First stage partial R2	0.5897	0.6025	0.5504	0.5024	0.6328	0.6670	0.5617	0.7340
Hansen J-statistic chi2	3.045 (0.693)	3.334 (0.648)	7.561 (0.182)	7.378 (0.194)	3.440 (0.632)	3.496 (0.624)	5.974 (0.308)	7.427 (0.190)
Kleibergen-Paap rk LM statistic chi2	24.79*** (0.000)	24.64*** (0.000)	22.47*** (0.001)	11.64* (0.078)	14.00** (0.029)	13.97** (0.030)	9.99 (0.125)	7.47 (0.279)
Kleibergen-Paap rk Wald statistic chi2	18.086*** (0.000)	203.59*** (0.000)	106.33*** (0.000)	91.23*** (0.000)	150.81*** (0.000)	191.15*** (0.000)	69.67*** (0.000)	205.04*** (0.000)
Kleibergen-Paap Wald rk F statistic	28.56*** (0.000)	32.03*** (0.000)	16.19*** (0.000)	12.78*** (0.000)	21.96*** (0.000)	27.58*** (0.000)	9.25*** (0.000)	20.75*** (0.000)
Anderson-Rubin Wald test chi2	22.36*** (0.001)	21.79*** (0.001)	49.41*** (0.000)	26.08*** (0.000)	9.40 (0.153)	8.09 (0.231)	21.22*** (0.001)	58.48*** (0.000)
Stock-Wright LM S statistic chi2	14.25** (0.027)	13.59** (0.034)	12.02* (0.061)	7.41 (0.284)	5.79 (0.447)	6.24 (0.397)	6.52 (0.367)	7.11 (0.310)

Note: p-values in parenthesis. *, ** and *** refer to 10, 5 and 1 percent level of significance, respectively.

The first five rows of Table 2 refer to variables that are part of growth regression, while the middle part of the table presents the results of openness determinants. Symbol √ indicates the period and group of countries that the results refer to. For example, in column 1 √ indicates that the results are given for the whole period (1995-2009) and EU27+5Balkan countries.

Given a remarkably strong match of the estimated results for the EU27+5Balkan (columns 1 and 5) and EU27 (columns 2 and 6) group of countries we interpret the obtained estimations together. Our results suggest that in both groups of countries and in both periods trade openness exerts a statistically significant and positive impact on growth. In the growth regression (upper part of the table) investment and population variables are also significant and of the expected signs, while the education and GDP gap do not exert a significant impact on growth. Turning to the estimated results for trade openness determinants, we observe a statistically significant and positive impact of formal institutions (WGI), export concentration (HH), productivity (PROD) and FDI per capita (FDIpc), in both periods: 1995-2009 (columns 1 and 2) and 2005-2009 (columns 5 and 6). This suggests that trade openness is increased through a larger FDI, better institutional development and higher productivity, as well as higher export concentration (lower diversification), pointing further to an indirect impact of these variables on growth. The impact of real exchange rate is statistically significant and negative for the period 1995-2009, while in the period 2005-2009 this variable is not statistically significant. RandD expenditures exert a statistically significant and negative influence on trade openness, with the exception of the 2005-2009 period for the EU27+5Balkan sample.

In the period under investigation some of the countries in our sample have been in the EU the whole period, some joined later, and some (Balkan countries) have not joined yet. It can be argued that even without the formal integration process the economic ties (through trade and financial links) have been strong between these countries, and that their joint analysis makes sense. However, in order to take account of the fact that both groups of countries anaylsed so far (EU27+5Balkan and EU27) include rather heterogeneous countries which have entered the EU at various points in time and may hence be more or less integrated with each other, we next investigate the two groups, EU15 and EU12, separately. The EU15 group has been integrated throughout the whole period 1995-2009; hence the results in columns 3 and 7 can be taken as an indication of whether the achieved level of political and economic integration process attenuates or reduces the effects of various aspects of openness on economic growth. The results for the EU15 sample suggest that the impact of trade openness on growth is statistically significant and positive (column 3). The same can be concluded for this group of countries when only the 2005-2009 period is considered (column 7). In the growth regression (upper part of the Table) only population variable is statistically significant in both the whole period and the 2005-2009 period. The other variables in growth regression are not statistically significant. As for the openness instruments, the results are significant and positive for the impact of formal institutions (WGI) and FDI per capita (FDIpc). This suggests that in the EU15 group trade openness is increased through a better institutional development and a larger FDI and both results

are in accordance with expectations. RandD expenditures, on the other hand, significantly and negatively impact openness. This result is not in line with expectations. Other potential determinants are not statistically significant. When it comes to the 2005-2009 period, only FDIpc and RandD variables are statistically significant, with the same signs as before, while the impact of institutions is not statistically significant.

In the EU12 group of countries our main variable of interest, openness, appears not to be statistically significant, which suggests that openness does not exert any influence on growth in this group of countries. The only significant variable impacting growth in the 1995-2009 period is investment, while in the period 2005-2009 it is investment and population variables that are statistically significant and of the expected signs. Openness is significantly influenced by export concentration (HH), productivity (PROD) and real exchange rate in the 1995-2009 period (column 4), while in the period 2005-2009 (column 8) it is only the export concentration variable that exerts a statistically significant impact on openness. The finding of insignificant coefficient on openness may suggest that the impact of openness on growth may be muted by the lower level of integration achieved in comparison to the old EU members. However, given that the impact is also insignificant in the 2005-2009 period, after the formal EU accession of the EU12 countries, it may be more likely that the relatively low number of observations does not allow a precise estimation of the impact of openness on growth.

In sum, trade openness is found to be an important determinant of growth, and the positive impact of openness appears to be attenuated by:

- stronger formal institutions – supporting the idea that they help dealing with external shocks;
- export concentration – indicating that greater concentration of exports on a few commodities, i.e. specialisation influences trade positively;
- productivity – suggesting that productivity improvements lead to higher openness and growth, possibly through increased competitiveness and/or intra-industry and intra-firm resource allocation;
- FDI per capita – speaking in favour of FDI being a complement rather than substitute to international trade.

These findings are in line with theoretically expected links put forward in Section 2. RandD expenditures and real exchange rate seem to affect trade openness negatively, albeit to a somewhat lesser degree. A negative influence of RandD can be explained through the influence of spatial dimension of technological spillovers. Namely, knowledge derived from RandD investment is likely to spill over from one country to another (Jaffe, 1986 and 1989). When deciding whether to invest in RandD or not, national decision-makers have to take into account this high mobility of technology. On the one hand economic actors and decision-makers need to invest in RandD to increase technological capacity and improve competitivensss, while on the other hand similar results could be achieved relying solely on technological spillovers (Rodriguez-Pose, 2001). The negative impact of RandD can be

taken to suggest the strong influence of technological spillovers. As for the exchange rate, an increase in real exchange rate leads to an increase in exports and a decrease in imports, which can influence trade openness measure (exports+imports in GDP) in either direction depending on the price elasticity of exports and imports. In EU15 countries the exchange rate, expectedly, looses significance since majority of these countries shares a common currency. Moreover, productivity and HH index are also not an important determinant, suggesting that export specialisation and higher productivity play a more important role for the less developed European countries' trade. Indeed this is confirmed by the EU12 results.

Since a distinctive characteristic of this paper is an analysis of other aspects of openness and their impact on growth we, following the links identified in Diagram 1, widen the analysis by taking into account the influence of financial openness and (formal and informal) institutions. We use FDI per capita as a measure of financial openness, with the idea that the larger the indicator the greater the openness. FDI per capita is instrumented via institutions, productivity, real effective exchange rate and RandD expenditure. The results are given in Table 3.

Table 3: Openness variable: FDIpc

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FDIpc	1.32***	1.23***	0.98**	1.53*	1.38**	1.36**	1.37*	-2.48***
	(0.004)	(0.002)	(0.022)	(0.090)	(0.027)	(0.025)	(0.083)	(0.000)
GDPgap	-1.43***	-1.10***	-1.59	-1.77	-2.40**	-1.94*	-2.57	4.22***
	(0.001)	(0.006)	(0.338)	(0.148)	(0.035)	(0.093)	(0.483)	(0.008)
INV	0.14**	0.181***	0.10	0.215**	0.07	0.155	0.10	0.44***
	(0.011)	(0.009)	(0.282)	(0.032)	(0.553)	(0.304)	(0.622)	(0.000)
POP	-2.04***	-2.33***	-1.85**	-1.97	-2.01***	-2.39***	-2.48***	-3.96***
	(0.000)	(0.000)	(0.023)	(0.135)	(0.005)	(0.004)	(0.002)	(0.007)
EDU	0.14	-0.04	-1.02	4.94	4.80	3.70	5.01	-8.71
	(0.950)	(0.985)	(0.567)	(0.571)	(0.407)	(0.536)	(0.406)	(0.303)
WGI	2.12***	2.04***	1.93***	1.70***	2.70***	2.60***	1.83**	3.06***
	(0.000)	(0.000)	(0.003)	(0.001)	(0.000)	(0.000)	(0.039)	(0.005)
PROD	3.74***	4.27***	5.14***	1.84	3.04*	3.35*	3.33	-6.23*
	(0.000)	(0.000)	(0.000)	(0.131)	(0.059)	(0.059)	(0.211)	(0.073)
REER	0.47	0.362	-0.85	3.28***	-0.20	-0.68	3.16	2.94
	(0.681)	(0.752)	(0.712)	(0.000)	(0.946)	(0.830)	(0.622)	(0.452)
R&D	-0.14	0.024	-0.29	-0.73**	-0.38	-0.29	-0.45**	0.100
	(0.368)	(0.869)	(0.129)	(0.044)	(0.124)	(0.272)	(0.027)	(0.865)
1995-2009	√	√	√	√				
2005-2009					√	√	√	√
EU27+5Balkan	√				√			
EU27		√				√		
EU15			√				√	
EU12				√				√
No. of obs.	211	197	128	69	87	82	54	28
Uncentered R2	0.9706	0.9717	0.9787	0.9889	0.9805	0.9801	0.9854	0.9934
Partial R2	0.1971	0.2283	0.1591	0.5487	0.2000	0.1971	0.1334	0.3244

Hansen J-statistic chi2	0.629 (0.889)	1.490 (0.684)	4.041 (0.257)	1.880 (0.597)	0.268 (0.966)	0.450 (0.929)	1.179 (0.758)	2.79 (0.425)
Kleibergen-Paap rk LM statistic chi2	18.79*** (0.000)	20.92*** (0.000)	12.01** (0.017)	10.21** (0.037)	5.35 (0.253)	4.98 (0.289)	5.45 (0.244)	7.94* (0.093)
Kleibergen-Paap rk Wald statistic chi2	47.36*** (0.000)	57.00*** (0.000)	22.90*** (0.000)	64.25*** (0.000)	18.19*** (0.001)	17.18*** (0.001)	12.13** (0.016)	54.75*** (0.000)
Kleibergen-Paap Wald rk F statistic	11.33*** (0.000)	13.60*** (0.000)	5.32*** (0.000)	13.97*** (0.000)	4.08*** (0.004)	3.82*** (0.007)	2.53* (0.053)	9.29*** (0.000)
Anderson-Rubin Wald test chi2	14.70*** (0.005)	14.62*** (0.005)	18.80*** (0.000)	17.76*** (0.001)	9.51** (0.049)	7.90* (0.095)	9.97** (0.040)	29.11*** (0.000)
Stock-Wright LM S statistic chi2	9.48** (0.050)	9.66** (0.046)	9.30*** (0.005)	6.94 (0.139)	5.18 (0.269)	5.64 (0.227)	4.73 (0.316)	6.89 (0.141)

Note: p-values in parenthesis. *, ** and *** refer to 10, 5 and 1 percent level of significance, respectively.

As was the case in Table 2, Table 3 reports the results for different groups of countries (EU27+5Balkan, EU27, EU15, EU12), as well as for two time periods (1995-2009 and 2005-2009). This again allows us to test whether the impact of financial openness is robust over different group of countries, time periods and possibly over the achieved level of economic and political integration.

The results for EU27+5Balkan and EU27 countries in columns 1 and 2 (for the whole period) and 5 and 6 (for the last 5 years) reveal that financial openness exerts a statistically significant and positive impact on growth in both groups of countries and in both examined periods. The only difference in the estimated growth regression is that in the later period investment loses statistical significance. In both periods the other two significant variables are GDPgap and population. As for the determinants of financial openness only institutions and productivity have a statistically significant impact, with both variables affecting financial openness positively and thus indirectly exerting a positive influence on growth.

In the EU15 sample financial openness is found to be statistically significant and positive in its impact on growth in both examined periods. In the growth regressions the only other significant variable is population which exerts the expected negative influence on growth. Turning to the determinants of financial openness we can observe a statistically significant and positive impact of institutions on financial openness in both periods, whilst productivity is statistically significant only in the whole period and RandD expenditures only in the later period.

The results for the EU12 group provide mixed and confusing evidence regarding the impact of financial openness on growth. In column 4 we can see that FDIpc exerts a statistically significant and positive impact on growth when the whole period 1995-2009 is examined. In this period investment also impacts growth significantly and positively, while the other variables are statistically insignificant. As for the determinants of financial openness the statistically significant variables are institutions, productivity and RandD expenditures, with the first two variables impacting openness positively and the third exerting a negative influence. The estimated results for the later period 2005-2009 (when the formal accession of EU12 was already accomplished) in column 8 suggest that all the variables in growth regression

except education are statistically significant. However, the impact of financial openness in this period turns strongly negative suggesting that FDIpc in this group of countries in the later period is growth depressing. As for determinants of financial openness, institutions and productivity exert a statistically significant influence with a negative coefficient on the productivity variable. We are, thus, left with mixed evidence on the impact of financial openness on growth in the EU12 group of countries. As suggested earlier when dealing with trade openness, caution is needed here as the number of observations is relatively low and the changing signs and significances may not be precisely estimated.

Taking the evidence from Table 3 together it may be concluded, with only one exception related to the EU12 group, that financial openness impacts growth positively, and this applies to both the whole period and the later period. Moreover, productivity and institutions are the main determinants of this aspect of openness, indicating that countries with a more productive labour force and better/more open institutions attract more FDI, which, in turn, exerts a positive impact on growth through diffusion of new technologies and know-how.

As suggested earlier institutions may play an indirect as well as a direct role in influencing growth. In Tables 2 and 3 we investigated the indirect influence of institutions on growth through their impact on trade and financial openness. However, as suggested by Diagram 1, openness of formal and informal institutions may be impacting growth directly also. Therefore, in Tables 4 and 5 we report the results from estimating the impact of formal and informal institutions on growth.

Table 4: Openness variable: VA

	(4)	(3)	(1)	(2)	(8)	(7)	(5)	(6)
VA	0.35 (0.626)	0.71 (0.571)	0.37 (0.706)	0.48 (0.860)	2.69 (0.191)	0.75 (0.794)	0.63 (0.774)	-3.367 (0.542)
GDPgap	-0.53 (0.151)	-0.541 (0.245)	1.15 (0.105)	-1.12 (0.223)	-0.96 (0.327)	-0.23 (0.830)	2.28** (0.026)	0.36 (0.873)
INV	0.22*** (0.000)	0.253*** (0.000)	0.14* (0.056)	0.279*** (0.000)	0.30*** (0.000)	0.31*** (0.000)	0.35** (0.033)	0.264** (0.017)
POP	-1.41*** (0.000)	-1.42*** (0.000)	-0.56 (0.233)	-1.41*** (0.008)	-1.28** (0.029)	-1.46** (0.015)	-1.54** (0.036)	-1.57 (0.302)
EDU	-0.62 (0.714)	-0.92 (0.614)	-0.86 (0.499)	9.57 (0.167)	-7.27* (0.093)	-8.87** (0.039)	-5.63 (0.140)	4.81 (0.781)
1995-2009	√	√	√	√				
2005-2009					√	√	√	√
EU27+5Balkan	√				√			
EU27		√				√		
EU15			√				√	
EU12				√				√
No. of obs.	299	262	147	115	122	105	59	46
Uncentered R2	0.6978	0.7008	0.5826	0.7711	0.6664	0.7136	0.5402	0.7756

Note: p-values in parenthesis. *, ** and *** refer to 10, 5 and 1 percent level of significance, respectively.

The evidence reported in Table 4 is not in line with our expectations of the direct impact of formal institutions on growth. This finding of no significant relationship seems to be robust across different samples of countries (EU27+5Balkan, EU27, EU15 and EU12) and both time periods (1995-2009 and 2005-2009). Regarding other variables, in the estimated growth regression investment and population appear to be statistically significant, with investment exerting a positive and population a negative influence on growth in most of the investigated samples.

Table 5: Openness variable: WVS

	(4)	(3)	(1)	(2)
WVS	-0.03 (0.561)	-0.029 (0.621)	-0.07** (0.039)	-0.006 (0.944)
GDPgap	0.82 (0.224)	0.548 (0.542)	0.58 (0.330)	1.55 (0.197)
INV	0.11 (0.179)	0.17** (0.024)	-0.01 (0.900)	0.11 (0.254)
POP	-1.50** (0.021)	-0.38 (0.807)	4.95*** (0.000)	-2.35* (0.077)
EDU	4.36 (0.288)	5.39 (0.167)	5.36** (0.013)	22.86*** (0.003)
1995-2009	√	√	√	√
2005-2009				
EU27+5Balkan	√			
EU27		√		
EU15			√	
EU12				√
No. of obs.	45	40	20	20
Uncentered R2	0.6216	0.6498	0.9528	0.6927

Note: p-values in parenthesis. *, ** and *** refer to 10, 5 and 1 percent level of significance, respectively. This table does not contain the results for the last five years because the World Values Survey was not undertaken in that period in our sample of countries.

Table 5 reports the results of our estimations of the impact of openness of informal institutions (as represented by the WVS variable) on growth in different samples of countries and for the period 1995-2009. Before interpreting the estimated regressions it should be stressed that these results should be taken with great caution given the small number of observations. This small number of observations is a consequence of the World Value Survey being conducted only sporadically. The results suggest that the statistically significant impact of institutional openness can be observed only for the sample of the old EU members (EU15) and with an unexpected - negative impact on growth. In this sample of countries we also observe a significant but positive impact of population, and the same

applies to education. Institutions in other samples do not exert a significant influence on growth. In the sample EU27 we can observe a statistically significant and positive impact of investment on growth. In other samples investment is not significant. It should also be mentioned that in the EU12 group education variable is significant and positive. However, given the small number of observations in Table 5 we are not very confident about the obtained results.

In summary, even though the theory suggests that openness of formal and informal institutions should be treated as an important determinant of growth, our empirical investigation does not confirm this (the only exception are the results for EU15 when WVS is used as a measure of openness). This is hardly surprising given that, as indicated above, it is very hard to properly measure these variables. A longer available WVS series should enable a better estimation; hence we leave this issue to be tackled empirically in the future. The results from Tables 2 and 3 are more indicative in this sense, i.e. institutions affect growth primarily indirectly – via their impact on trade and financial openness, i.e. through eliminating barriers to free financial and trade flows.

4. Concluding remarks

This paper investigates empirically the impact of international openness on growth in a sample of 32 European economies, with openness defined broadly - to account not only for the usual trade openness, but also to account for other aspects like financial openness and institutional openness. The results indicate that international openness plays an important role in affecting growth. This is true for trade and financial openness; whereas institutional openness is found to be of importance only indirectly – via its impact on trade and FDI flows. More precisely, we find that the the positive impact of trade openness is attenuated by stronger formal institutions (supporting the idea that they help dealing with external shocks), export concentration (indicating that greater concentration of exports on a few commodities, i.e. specialisation influences trade positively), productivity (suggesting that productivity improvements lead to higher openness and growth, possibly through increased competitiveness and/or intra-industry and intra-firm resource allocation) and FDI per capita (speaking in favour of FDI being a complement rather than substitute to international trade). Moreover, we find that export specialisation and higher productivity play a more important role for the less developed European countries (EU12). Financial openness is also found to impact growth positively, with productivity and institutions as its main determinants, indicating that countries with a more productive labour force and better/more open institutions attract more FDI, which, in turn, exerts a positive impact on growth through diffusion of new technologies and know-how. Institutions, as indicated before, exert their influence on growth primarily indirectly, whereas their direct influence is not confirmed by the data.

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Appendix

For diagnostic testing we use several tests, reported in Tables 2 and 3. These are explained below.

Hansen J statistic is a test of overidentifying restrictions. The joint null hypothesis is that the instruments are valid i.e. uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the (L-K) overidentifying restrictions (where L-K is the number of overidentifying restrictions).

Kleibergen-Paap rk LM statistic chi2 and *Kleibergen-Paap rk Wald statistic chi2* are tests for underidentification, while *Kleibergen-Paap Wald rk F statistic* tests weak identification. The underidentification tests test the null hypothesis of whether the matrix of reduced-form coefficients on the L1 excluded instruments has rank equal to K1-1 where K1 is the number of endogenous regressors. Under the null (that the equation is underidentified) the statistic is distributed as chi-squared with degrees of freedom equal to (L1-K1+1). A rejection of the null indicates that the matrix is full column rank; i.e. that the model is identified. Weak identification arises when the excluded instruments are correlated with the endogeous regressors but only weakly. When errors are assumed to be i.i.d., the test for weak identification automatically reported by *ivreg2* is an F version of the Cragg-Donald Wald statistic. Stock and Yogo (2005) have compiled critical values for the Cragg-Donald F statistic for several different estimators, and the same critical values are used for the Kleibergen-Paap tests (details can be found in Kleibergen and Paap, 2006; Cragg and Donald, 1993).

Additional two statistics provide inference for testing the significance of the endogenous regressors in the structural equation being estimated, and these are *Anderson-Rubin Wald test chi2* and *Stock-Wright LM S statistic chi2* tests. The null hypothesis tested in both cases is that the coefficients of the endogenous regressors in the structural equation are jointly equal to zero and that the overidentifying restrictions are also valid. The tests are equivalent to estimating the reduced form of the equation (with the full set of instruments as regressors) and testing that the coefficients of the excluded instruments are jointly equal to zero. Both statistics are distributed as chi-squared with L1 degrees of freedom, where L1 is the number of excluded instruments (details can be found in Anderson and Rubin, 1949; Stock and Wright, 2000).

Efficiency of the Albanian banking system: Traditional approach and Stochastic Frontier Analysis

Suela Kristo[1]

Abstract

Efficiency issues become even more sensitive for post-communist European countries and for Albania as well, as their economies have created relatively new financial systems being currently of little experience, moreover when they become part of EU. Their survival requires them among others, to be as efficient as possible. The paper focuses on the dynamics of bank efficiency banking system as a whole and for each of the banks in particular. Firstly, the analysis is done through traditional indicators. These indicators clearly show a poor performance and decreased efficiency of Albanian banking system after year 2007. Then, is estimated the cost efficiency through Stochastic Frontier Approach (SFA). This efficiency estimation captures essentially the deviation that a bank has from the theoretical best-practice bank. Results show that in particular, the largest banks (which have the largest market share G3 group) seem to be more efficient than the smaller banks. However, the differences that they have on each other are much smaller than in the case of traditional indicators. Moreover, it is not clear the relationship between ROA or size of the bank with the cost efficiency.

Keywords: bank efficiency, Albanian banking system, SFA

JEL Classification: G21, G14, C33

1. Introduction

Banks are a service industry. They contribute to economic growth by providing financial assets to facilitate the production in industries. Although, the direction of the finance-growth nexus is country-specific (Fukuda and Dahalan, 2012), an efficient banking sector provides the greatest contribution to economic growth and at the same time on welfare. Banks contribute more to economic growth by promoting the accumulation of capital through credit supply.

Bank efficiency studies show that the inefficiencies in this market exist for a long time. It is possible that governments and respective authorities protect the banking

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markets, particularly in emerging markets, Matthews (2010). In this way, management objectives will be different from those of profit maximization or cost minimization, given that "they will be protected anyway". Moreover, the process of financial integration in the European banking industry is accompanied by the debate about the benefits of strengthened competition in credit markets and greater efficiency (Kooli, 2012). Therefore, this paper aims to know how efficient the Albanian banking system is, which belongs to the emerging markets and it has been passed 20 years since it was restructured. During these years, none of the Albanian banks comes out from the market. In addition, only a merger between banks has been occurred. So, all of this has happened because the banks and the whole system are efficient and support very well the competition in this market, or that "they are more protected than efficient"?

To answer this question, first I provide some evidence for the efficiency level and its development focused more on the period 2002-2011. Then it is estimated the cost efficiency through Stochastic Frontier Approach (SFA). At the core of this method is the evaluation of the cost efficiency level for each bank through the distance that each of them has from best-practice bank. In addition, this indicator is compared with traditional indicators to check the compatibility between them.

The paper is organized as follows: Section 2 gives the basic theory of efficiency measurement ways in the banking sector, to see better the differences between them. Section 3 analyzes the level and development of traditional and simple indicators that measure efficiency in the Albanian banking market. The fourth section presents in details the methodology of SFA approaches, variables and data. On the fifth and sixth section are presented the cost efficiency results and conclusions of the paper.

2. Empirical findings on banks efficiency in the emerging countries

The efficiency of banking institutions is an important factor that fosters the economic development in transition economies (Bonin and Wachtel, 2003). There are numerous studies on banking efficiency, some of which belong to the economies in transition. Many studies focused on the banking sector were performed for only one country in transition. A lot of them investigate efficiency in the relationship with other variables. Moreover, the estimation methodologies vary across these studies. I briefly examine some of the evidence provided by these studies in this section.

In their study, Kraft and Tirtiroglu (1998) measured scale efficiency and X-efficiency of banks in Croatia for the period 1994-1995. They showed that the newly established banks were less efficient, but more profitable than the older privatized banks and the state ones. Whereas, Jemric and Vujcic (2002) analyzed banks in Croatia between 1995 and 2000 and showed that the foreign and newly established banks were more efficient. By analyzing the banking sector in Hungary in the transition period Hasan and Marton (2003) showed that the foreign banks perform better, followed by domestic private and state-owned banks. Havrylchyk (2006) analyzed the efficiency of the banking market in Poland for the period 1997- 2001. He showed that the efficiency level did not increase over

the analyzed period. Moreover, foreign banks newly entered on the market presented a higher level of efficiency than the local banks or than the foreign banks that acquired local banks. Asaftei and Kumbhakar (2008), estimated the cost efficiency of banks in Romania for the period 1996-2002. The results of the research indicate that the cost efficiency of all banks in Romania increases with the improvement of the regulation framework and with the adjustment of the monetary policy to the market conditions. Dardac and Boitan (2008) measured the relative efficiency of a homogeneous group of credit institutions. They identified the factors generating inefficiency, highlighting the impact of the management performance on bank efficiency. Mihajlović et al. (2009) ranked banks in Serbia based on the efficiency. However, no other study to my knowledge has explored bank efficiency in Albania. This paper attempts to fill in the gap in the literature by providing empirical evidence for Albanian banks and banking system with the help of frontier methods.

On the other hand, in the past studies concerning the comparative efficiency in the emerging countries have intensified. They focused on the analysis of the ownership impact form on the efficiency of banks, this because of the increasing presence of foreign investors in the financial systems in the transition economies. Thereby, Drakos (2002) analyzed the effect of structural reforms on the bank efficiency in six states in Central and Eastern Europe in the period 1993-1999. Grigorian and Manole (2002) performed an analysis of the banking sector in 17 states from Central and Eastern Europe in the period 1995-1998. Their analysis suggests that the foreign ownership and consolidation is likely to improve efficiency of banking operations and the effects of prudential tightening on the efficiency of banks vary across different prudential norms. Weill (2003) analyzed the impact of the nature of ownership form on the efficiency of 47 banks in the Czech Republic and Poland in 2007. This study showed that foreign banks had a higher level of efficiency than the local banks. Bonin et al. (2005) analyzed the effect of the ownership form regarding 225 banks in 11 states in transition for the period 1996-2000. They showed that the privatization of banks was not enough to increase the efficiency of banks and that government banks were inefficient than the private banks. Rossi et al. (2005) found significant differences among bank management of 9 countries in Central and Eastern Europe in the period 1995-2002. They provided some evidence of an increasing tendency over time in profit efficiency and, to an even stronger extent, in cost efficiency. Moreover, cost and profit efficiency scores are negatively correlated both on a country wide as well as on a bank by bank basis. Fries and Taci (2005) examined the cost efficiency of 289 banks in 15 East European countries. They found that banking systems in which foreign-owned banks have a larger share of total assets have lower costs and that the association between a countries progress in banking reform and cost efficiency is non-linear. Yildirim and Philippatos (2007) studied the efficiency of banking sectors in 12 countries in transition in Central and Eastern Europe during the period 1993-2000. The authors showed that the managerial inefficiencies in CEE banking markets were found to be significant, with an average cost efficiency level for 12 countries of 72 and 77 percent by the DFA and the SFA, respectively. The alternative profit efficiency levels are found to be significantly lower relative to cost efficiency. In another study on the bank efficiency in Central and Eastern Europe, Koutsomanoli-Filippaki et al. (2009) analyzed

the data for the period 1998–2003 and showed found that productivity change in CEE is driven by technological change rather than efficiency change. Andries and Cocris (2010), analyzed the efficiency of the main banks in Romania, the Czech Republic and Hungary for the period 2000-2006. Their results of the analyses showed that the banks in the three East-European countries reach low levels of technical efficiency and cost efficiency, especially the ones in Romania, and that the main factors influencing the level of banks efficiency in these countries are: quality of assets; bank size, annual inflation rate; banking reform and interest rate liberalisation level and form of ownership. Banerjee (2011) examines the relative rankings in efficiency of individual countries across the studies and the effect of ownership structure on bank performance. According to him the Czech banking system ranks among the highest nontechnical and profit efficiency but lowest in cost efficiency. Slovenian and Estonian banks rank among the most cost efficient banks.

Albania is excluded from the above studies notably due to the lack of complete information. A few studies offer comparative information regarding the efficiency of banks in transition economies including Albanian banking system. Turk-Ariss (2010) studied 60 developing countries over the period 1999-2005. The profit efficiency indicator in Albania appear to be higher compared to the some eastern European countries, but lower in term of cost efficiency.

Fang et al. (2011) examines the cost and profit efficiency of banking sectors in six transition countries of South-Eastern Europe over the period 1998–2008. They found that Albania and F.Y.R.O.M. have relatively high cost efficiency, because of the relatively high level of banking sector concentration. Bulgaria has the highest level of profit efficiency, followed by F.Y.R.O.M., Albania, Croatia, and Serbia. Albania had a high level of profit efficiency before 2003 and this could be attributed to the fact that until 2003 still over 70% of the bank assets were invested in government treasuries that had high interest margin. These and other studies differ considerably in sampling, methodology, and measurement. Therefore, the comparison of the general conclusions should be done carefully.

3. Efficiency in the Albanian banking market. Traditional efficiency indicators

Traditional indicators will first evaluate the Albanian bank efficiency. The traditional indicators of the efficiency are related with the analysis of various financial ratios. Among them are: net interest margins (NIM), cost-income ratio, overhead costs to total assets, operating expenses to operating revenues and return on assets (ROA). Higher levels of net interest margins (NIM), overhead costs indicate lower levels of bank efficiency, as they incur higher costs and there is a higher wedge between lending and deposit interest rates. Moreover, cost-income ratio, overhead costs to total assets and operating expenses to operating revenues indicate lower levels of cost efficiency with higher ratios. Whereas, return on assets (ROA), regarded as one of the basic indicators of bank profitability or for banking system as a whole. There is almost a positive trend of this indicator for the period 2002-2007 (table 1) due to better financial result of banks from the main operations, in spite of high operation expenses from expansion. After the year 2008 has a decline trend of this

indicator giving a more low-performance of the Albanian banking system. ROA shows a positive trend in 2010 due to the rapid growth of net profit compared to an almost negligible increase in average assets. However, it seems that there has not been a sustainable growth, because the year 2011 shows a significant downward trend.

Table 1: Some efficiency indicators for Albanian banking system (in %)

Year	ROA	NIM	Operating expenses to operating revenues	Cost to income ratio	Overhead costs to total assets
2002	1.2	2.91	55	66.01	2.46
2003	1.24	3.23	49	64.88	2.16
2004	1.28	3.08	61	66.74	2.36
2005	1.4	3.75	56	54.64	2.26
2006	1.36	4.22	54	61.02	2.33
2007	1.57	4.09	51	56.06	2.19
2008	0.91	4.13	57	52.67	2.42
2009	0.42	4.04	57	55.82	2.44
2010	0.72	4.32	53	51.86	2.30
2011	0.22	4.27	62	49.01	2.09

Source: Bank of Albania (2003-2012)

There is a positive trend about NIM in the period under consideration, indicating lower levels of banking system efficiency. Generally, during the years 2007, 2008 and 2009, appear minor changes of NIM. This has come due to the balanced development of the two components. Performance of the NIM in 2010 shows a slight increase, which is mainly due to the decline in the component that determines the financial cost of earning assets. The NIM fell slightly in 2011 due to the higher growth rate of paying liabilities compared to the increase in average earning assets. Operating expenses to operating revenues is more unstable. Its improvement (2006, 2007) has been influenced from such developments as the network extension of various banks, provision of a broader variety of services and products, intensified marketing and overall improvement of bank–customer relations. However, after year 2007, the efficiency indicator has a significant increase in comparison with the previous period. It shows the change of banking activity direction and its repression of income generation, turning back the ratio at 2004 levels. This because of the more moderate increase in total expenses, coupled with the sharper decline in operating

income. Performance of overhead costs to total assets appears generally balanced, during the years of the period under consideration, with a negative trend in last three years. Cost-income ratio shows this negative trend as well, but not only for these years. This trend shows improvement of cost efficiency for the banking system.

Comparing net interest margins, cost to income ratio and overhead costs to total assets for some countries of South Eastern Europe in year 2011, show that these indicators put Albanian as the most efficient banking system (table 2). The lowest indicators appear for Serbia. ROA indicator does not show the same thing as the other indicators. The sharp fall in income was highly driven by the high loan loss provisions, which have a direct negative impact on the ROA for Albania.

Table 2: Some efficiency indicators for SEE countries in 2011

Efficiency indicators	Albania	Bosnia and Herzegovina	F.Y.R.O.M.	Montenegro	Serbia
Cost to income ratio (%)	49.01	63.26	65.71	66.03	87.74
Net interest margin (%)	4.27	4.44	4.30	4.96	5.37
Overhead costs to total assets (%)	2.09	3.33	3.03	3.90	16.84
Return on assets (%)	0.22	0.98	0.38	-0.36	0.96

Source: Bank of Albania (2013)

The observation of traditional indicators of efficiency does not give a clear idea about the efficiency of the Albanian banking system. Therefore, to understand better the efficiency of Albanian banking system the cost efficiency indicator based to the SFA method, will be used.

4. Stochastic Frontier Approach for Efficiency in the Albanian banking market

While in the above section it was analyzed the efficiency in the Albanian banking market by traditional indicators, in this section I will evaluate it by an alternative approach. This methodology relates to the measurement of cost efficiency by Stochastic Frontier Approach (SFA).

4.1 Methodology and data

The focus of research on bank efficiency has shifted from the traditional approach of analyzing financial ratios to estimating efficiency through frontier techniques. Financial ratios are single factor measures of performance, and that they may be misleading indicators of efficiency because they do not control for product mix or input prices. Farell (1957) was the first that introduced the idea of efficiency of a production unit, under the concept of "input oriented measure". Throughout the past two decades, hundreds of articles have developed the idea of Farell. However, the two most widely used approaches to bank efficiency measurement in transition economies, are the stochastic frontier approach (SFA), a parametric method, and data envelopment analysis (DEA), a non-parametric method. The advantage of SFA is that it can disentangle the inefficiency term from the residual. DEA method assumes that all efficiency deviations are caused by the company. Nevertheless, there are some elements, such as the legislative framework, level of competition, etc., which cannot be controlled by the company and which affect the performance of the company. On the contrary, the SFA method allows for the modeling of these factors by introducing the random error in the specification of the determining model for the frontier efficiency (Murillo-Zamorano, 2004).

The main problem of SFA is the misspecified functional form. On the contrary the most important advantage of DEA is that it does not require in advance assumptions about the production function's analytical form. This method does not require a model specification for production or cost functions, but it uses linear programming methods to construct the efficient frontier from the observed input-output ratios as a piece-wise linear combination of the most efficient units.

There are a lot of studies that employs Data Envelopment Analysis on banking efficiency in transition countries (Grigorian and Manole, 2002; Tomova, 2005; Jemric and Vujcic, 2002; Mihajlović et al., 2009). There are many other that employs Stochastic Frontier Approach (Kraft and Tirtiroglu, 1998; Yildirim and Philippatos, 2002; Bonin and Wachtel, 2003; Bonin et al., 2005; Fries and Taci, 2005; Yildirim and Philippatos, 2007; Karas et al., 2010; Turk-Ariss, 2010). However, some of the researcher apply two or more techniques to an identical data set. Some of them compare parametric and non-parametric techniques like Bauer et al. (1998), Casu and Girardone (2002), Beccalli et al. (2006), Theodoridis and Psychoudakis (2008), Andries and Cocris (2010), Banerjee (2011). In fact, there is no consensus which of the available methods is the best. This paper employs the stochastic frontier analysis (SFA). The most important reason why SFA is selected for analysing efficiency in the Albanian banking system is that in transition economies the quality of banking data is not perfect and measurement errors are quite widespread. Some authors argue that parametric methods, which are more robust to data problems, would constitute more suitable empirical tools for analyzing banking efficiency (see Fries and Taci, 2005). However, in further research should use multiple techniques, especially parametric versus non-parametric techniques, to check for the robustness of results.

The SFA approach is based on the idea of Aigner et al. (1977) and Meeusen et

al. (1977). It includes the evaluation of specific parameterized efficiency frontier with a composite error term. The error term consist of nonnegative inefficiency and noise components. Because of its deterministic character, the Translog function is generally preferred form. Other form are Cobb-Douglas and Fourier function. However, the last function is more controversial in the empirical literature, because it may be unable to reach close approximation and may result in inconsistent parameters[1]. Given the multiplicity of bank functions, I will choose the Translog function model which seems to be adapted to the multi-criteria character of banks efficiency. Indeed, this functional form makes it possible to take into account the multiple complementarities links between explanatory factors and it does not impose any restriction. Moreover, panel data with random errors will allow to mitigate the weakness of available quantity on banks level data. Specifically, efficiency scores are estimated using the Battese and Coelli's (1992) time-varying stochastic frontier approach for panel data with firm effects. All estimations are run using bank fixed effects. Using the maximum likelihood technique, bank efficiency is estimated for each bank *i* as Battese and Coelli (1992).

Specification according to the SFA model is as follows:

$$LnC_{it} = f\,(lnQ_{it},\ lnW_{it}) + \varepsilon_{it} \tag{1}$$

where *C* is total costs, *Q* denotes bank output, while *W* indicates input prices defined below. Error ε_{it} decomposed into $v_{it} + u_{it}$, where v and u are two components that are assumed multiplicatively separable from the rest of the function. While v_{it} is the two-sided disturbance that accounts for random factors assumed to be independently and identically normal distributed with zero mean and variance σ_v^2. The other component u_i is a one-sided non-negative inefficiency term and assumed to be half normally distributed with mean zero and variance σ_u^2.

Constrained by the type of data (it was not possible to separate the data at disposal into components), I will use only one output. According to Shaffer (1993) and Berg and Kim (1994), this should be the total assets. The rationale for using such a variable is that the flow of the products and services produced by a bank is proportional to its total assets[2].

In order to estimate the cost function, linear homogeneity restrictions in input prices have to be hypothesised. Several researchers do this by normalising costs and input prices by dividing them with one of the input prices, such as in Pruteanu-Podpiera et al. (2008) who analyse banks in the Czech Republic, or Cebenoyan et al. (1993) for the USA, etc. I will use the ratio with the labour price. The reason is that all the other independent variables could be highly correlated to each other in almost all the cases. Moreover, regarding alternative estimations conducted, using the chosen variable could produce a better estimation than if using other variables for the normalisation process. Hence, using the frontier technique, I estimate the translog cost function, of the following form:

[1] See Kumbhakar and Lovell (2000) for a discussion of these functions and the other specifications

[2] Fernández de Guevara et al., 2007; Carbó et al., 2009; Berger et al., 2009; Turk-Ariss 2010, among others use total assets as output in this field of research.

$$\ln C_{it} = \alpha_0 + \alpha_1 \ln Q_{it} + \frac{1}{2}\alpha_2 (\ln Q_{it})^2 + \alpha_3 \ln w_{1,it} + \alpha_4 \ln w_{2,it}$$
$$+\alpha_5 \ln w_{1,it} \ln w_{2,it} + \frac{1}{2}\alpha_6 \left(\ln w_{1,it}\right)^2 + \frac{1}{2}\alpha_7 \left(\ln w_{2,it}\right)^2 \quad (2)$$
$$+\alpha_8 \ln Q_{it} \ln w_{1,it} + \alpha_9 \ln Q_{it} \ln w_{2,it} + \varepsilon_{it}$$

where:

ln natural logarithm

i bank's index;

t time index;

C_{it} total costs over labour price (measured as ratio of personnel expenses to number of employees)

Q_{it} total assets of bank *i* at time *t*;

$W_{1,it}$ capital price (measured as ratio of operating and administrative expenses to fixed assets)[3] over labour price

$W_{2,it}$ fund price (measured as ratio of interest expenses to total deposits) over labour price

α_0 constant

$\alpha_{1,2,3...9}$ coefficients of respective variables

ε_{it} error of estimation

The empirical model in this research is performed in the Stata software and the results of cost efficiency come from software calculation. Cost efficiency measures the ratio of the minimum potential total cost to the total observed cost. For example, cost efficiency of 0.65 suggests that bank lose about 35% of its costs compared with the best practice bank due to mismanagement, outdated technology, etc... The study covers only the period of 2002-2011 because of the lack of consistent available data prior 2002. Data on the Albanian banking system are taken from the database provided by the Bank of Albania. These data are in the form of an unbalanced panel form, with 153 observations and 17 banks. The American Bank of Albania (now ISPA) and the Italian Albanian Bank are considered as separate banks until 2007 before their merger. In 2008-2011 they are consider as Intesa Sanpaolo Bank of Albania (ISPA), because of their merger.

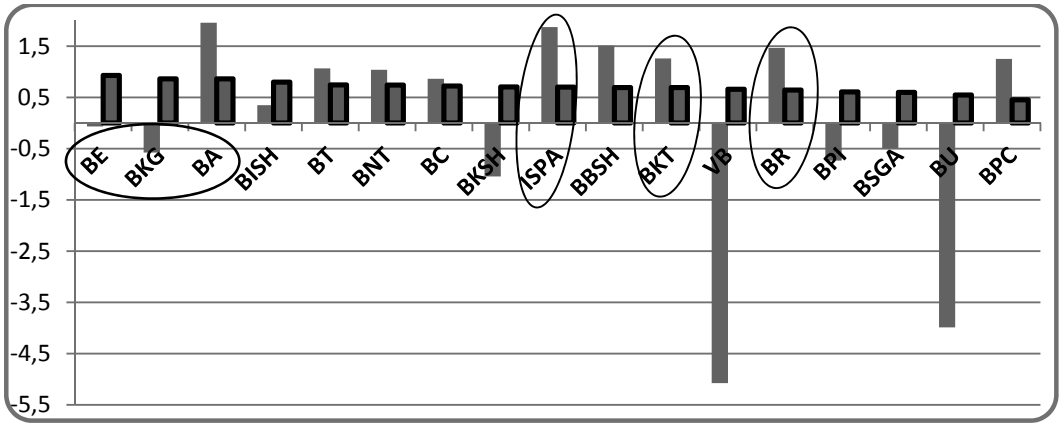
4.2 Results

I have applied the frontier technique to estimate equation (2). The empirical results are shown in Table A2 in the appendix. Estimation of the model parameters indicates that

[3] See Fernández de Guevara et al., 2005; Carbó et al., 2009; Fungacova and Weill 2009, among others.

generally these parameters are statistically significant. Moreover, the Wald test shows a statistically significant model in general, at the level of 99%. Cost efficiency results for the Albanian banking system, measured by SFA technique, show that generally differences between banks are relatively small (Figure 1). Higher average values over the study period reach: Emporiki Bank, National Bank of Greek and Alpha Bank. While smaller values take ProCredit Bank and Union Bank. Greek banks presented the highest value of efficiency hence they have the greatest impact on group's efficiency.

Figure 1: Average cost efficiency and ROA[4] for each bank in Albania for the period 2002-2011



Source: Author's calculations

ROA for each bank[5] of G3 is more centred toward the group's average than for other banks in the system. However, they are not in the top of ranking by cost efficiency as are regarding the ROA indicator. These banks are very similar in terms of indicators of profitability than in terms of cost efficiency. ROA for three banks (BE, BKG and BSGA) of G2 group is estimated in average at negative levels for the period of the study, where two (BE and BKG) of these are the most efficient. Only two (BA and BPC) out of five G2 banks have a positive performance. But, in terms of cost efficiency, BPC stands at the end of the ranking. Generally, G1 banks are unable to generate sufficient profit. In average only two (BBSH and BNT) out of six G1 banks reports positive net result, while most of the banks fail to cover operating expenses with operating income. In general, this indicates that small banks have a pronounced lack of efficiency, associated by a limited volume of banking activities. However, two banks with positive ROA indicator have higher efficiency cost

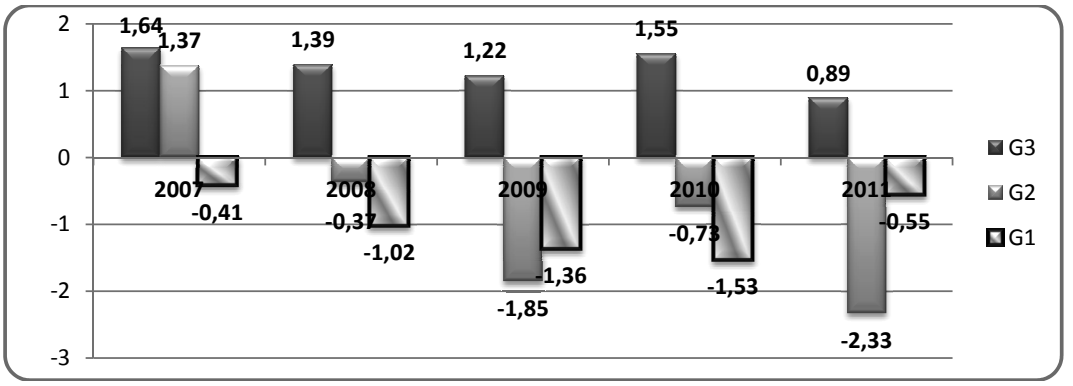
[4] Average cost efficiency have only positive value, while ROA may be positive or negative

[5] Classification of banks into groups and the bank name abbreviations are in the Appendix, Table A1.

than other banks. It is not clear the relationship between ROA or size of the bank with the cost efficiency.

ROA by bank groups shows higher profitability for G3 banks, followed by G2 and G1 banks (Figure 2). This dynamic continues in following years of the period study with year 2009 and 2011 exception, where the G2 group is the last classified. More noticeable in this graph is the performance of the G3 group, distinctly higher and stable than the other two groups.

Figure 2: ROA indicators by bank peer-groups (in %)

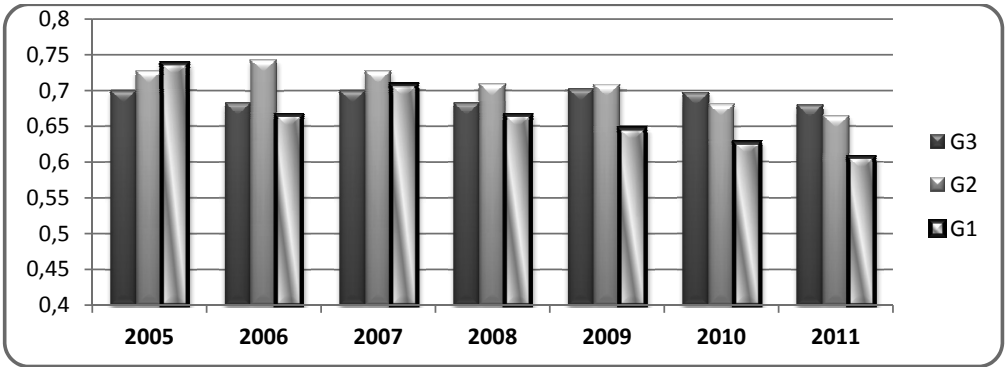


Source: Bank of Albania (2008-2012)

ROA for the G2 group has a larger downward trend in recent years, and it is quite volatile for banks within the group. Better situations looks in 2010. However, performance in 2011 is unlikely to preserve this trend. During this year, this indicator worsens. Among others this deterioration, may have come because of the Union bank's classification into second group. Whereas ROA for G1 banks displays even higher negative values, showing worsened figures due to the deeper losses. Even worse appears the performance of this group in 2010. In 2011, appear signs of improvement, but these generally come from changes in the group's composition.

Observation of development of cost efficiency for groups (Figure 3) compared with ROA indicator (Figure 2) show that this indicator will give the same classification of peer groups in the last two years of study period as ROA indicator we have seen above. Switching of these banks from one group to another has had its influence on the outcomes of the groups. For example, the highest value in 2006 for the G2 group is due to the classification in this group of two Greek banks: Alpha Bank and Emporiki Bank that come from G1 group. The classification of Alpha Bank into G3 group, in year 2007, makes very small the difference between the two biggest groups.

Figure 3: Cost efficiency by bank peer group[6]

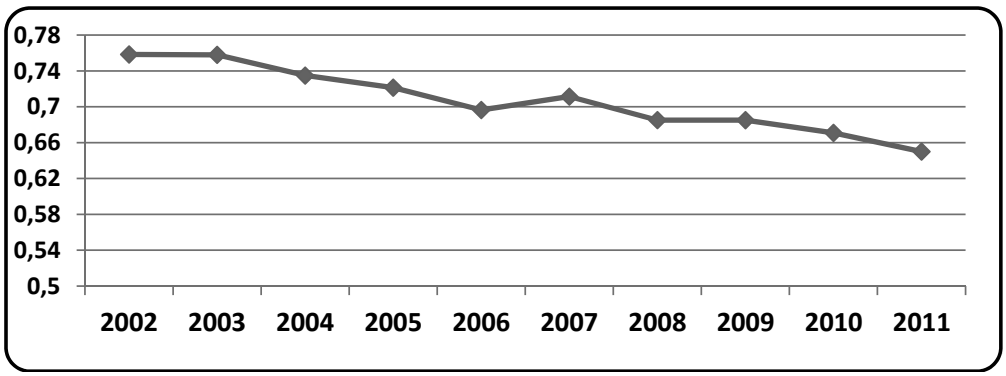


Source: Author's calculations

The difference between groups is not as deep as in the case of return on assets. Moreover, the difference between the third and the second group is smaller than the difference between the second and the first, implying that larger banks find it easier to provide revenue without being so efficient. This fact casting doubt again, that providing the highest revenue is not due to higher efficiency, but maybe because of greater power that they exercise on the market, or due to a lack of competition in this market.

Unlike traditional indicators, cost efficiency shows a declining trend in almost all the years of the periods taken into consideration (Figure 4). This throws doubt that the banks with foreign capital that entered massively in the Albanian banking market have no incentive to be more efficient. This lack of incentive may come due to the low pressure of competition, inadequate credit information, weaknesses in judicial systems or other financial and macroeconomic factors.

Figure 4: Average cost efficiency for Albanian banking system



Source: Author's calculations

[6] The graph shows the tendency for the groups from 2005, due to changes from this year of the banks classification methodology into groups.

5. Concluding remarks

In this paper, I estimate and analyse the efficiency of the Albanian banking system for the period 2002-2011. I use standard indicators for bank efficiency, namely net interest margins (NIM), cost-income ratio, overhead costs to total assets, operating expenses to operating revenues and return on assets. The observation of traditional indicators of efficiency does not give a clear idea about the efficiency of the Albanian banking system. Therefore, to understand better the efficiency of Albanian banking system I used cost efficiency indicator based to the SFA method. Moreover, it is not clear the relationship between ROA or size of the bank with the cost efficiency. There are small banks with negative ROA that are more efficient than large banks with ROA at higher positive levels. The trend of cost efficiency shows a negative tendency. This may come due to the low pressure of competition, inadequate credit information, weaknesses in judicial systems or other financial and macroeconomic factors. Therefore, the analyses of the efficiency cost lead to the conclusion that inefficient banks in Albanian banking market do not lack. Therefore based on such analysis and limited information, I could not answer the second part of the paper question, if some inefficient banks that could not generate profits for years, are more protected.

The future research may concern at assessing profit and technical efficiency, factors that influence in efficiency for Albanian banking system, in order to identify the suitable policies for increasing banks efficiency. Further research can also compare parametric and non-parametric techniques for the same database.

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Appendix

Table A1: Classification of banks into groups based on their activity size at the end of 2011

Banks	**Groups**	**Year**
United Bank of Albania **(BBSH)**	**G1** banks sharing below 2% of total banking system's assets each	2003-2011
Veneto Bank **(VB)** Veneto Banka)		2004-2011
International Commercial Bank **(BNT)**		2002-2011
First Investment Bank **(BPI)**		2002-2011
Credit Bank of Albania **(BKSH)**		2004-2011
Union Bank **(BU)**		2006-2011
Procredit Bank **(BPC)**	**G2** banks sharing 2 to 7 percent of total banking system's assets each	2002-2011
Emporiki Bank-Albania **(BE)**		2002-2011
National Bank of Greece Albania Branch **(BKG)**		2002-2011
Alpha Bank **(BA)**		2003-2011
Société Générale Albania Bank **(BSGA)**		2004-2011
Raiffeisen Bank, **(BR)**	**G3** banks sharing more than 7% of total banking system's assets each	2002-2011
National Commercial Bank **(BKT)**		2002-2011
Intesa Sanpaolo Bank Albania **(ISPA)**		2002-2011
Tirana Bank **(BT)**		2002-2011
Credins Bank **(BC)**		2003-2011
Italian Albanian Bank **(BISH)**	Merger in 2008	2002-2007

Source: Bank of Albania (2012)

Table A2: Results taken from the cost function empirical estimation

Variables	Coefficients	std.errors
_cons	-3.568 *	(1.989)
lnw_1	1.597 ***	(0.612)
lnw_2	0.454*	(0.268)
lnq	0.924**	(0.372)
$1/2(lnw_1)^2$	-0.182 *	(0.096)
$1/2(lnw_2)^2$	-0.079 ***	(0.028)
$1/2(lnq)^2$	0.028*	(0.016)
$lnqxlnw_1$	0.187 ***	(0.041)
$lnqxlnw_2$	-0.085 ***	(0.013)
lnw_1xlnw_2	-0.129*	(0.072)
Overall significance	Wald chi2(9) =1327.62 Prob > chi2 =0.000	

Statistical significance:* p<.1; ** p<.05; *** p<.01

Source: Authors calculations

Independence and Uniqueness of the Mixed-Strategy Equilibrium in Social Networks

Darong Dai[1]

Abstract

We develop topological analysis of social-network effect on game equilibrium in the context of two- player asymmetric normal-form games and also in evolutionary sense. Firstly, it is confirmed that the game equilibrium in many social networks cannot be established through that in a well-mixed population. In other words, we have proved the independence of the mixed-strategy equilibrium in social networks. Secondly, it is demonstrated that the game equilibrium exhibits injective property with respect to the corresponding social-network effect under consideration. That is, the uniqueness of the mixed-strategy game equilibrium in a given social network is identified. Thirdly, it is argued that uniqueness implies independence for a wide range of social networks and we have even derived the biggest sets of social networks in which independence and uniqueness hold true, respectively, in the underlying game. To sum up, we have provided qualitative characterizations about topological properties of the mixed-strategy game equilibrium in general social networks.

Keywords: social network, asymmetric game, mixed-strategy equilibrium, independence, uniqueness

JEL Classification: C62, C72

1. Introduction

Noting that social networks have been paid heavy attention to in recent studies, including economics (see, Bandiera and Rasul, 2006; Goyal, 2007; Acemoglu et al., 2010, 2011, 2012; Golub and Jackson, 2010), biology (e.g., Nowak, 2006; Ohtsuki et al., 2006; Pacheco et al., 2008; Tarnita et al., 2009; Fu et al., 2010; Allen et al., 2012), sociology (Zhang, 2004; Jackson, 2008) and physics (Pacheco et al., 2006; Ohtsuki et al., 2007), and the theory about game equilibrium in well-mixed populations has been well-established (see, Weibull, 1995; Hofbauer and Sigmund, 2003), the present paper is encouraged to discuss the question that whether or not we can use the game equilibrium derived in well-

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mixed populations to effectively approximate the equilibrium of non-trivial social networks. Accordingly, the major goal of the paper is to illustrate that social-network structure does affect the resulting game equilibrium, which is a mixed-strategy equilibrium in general, and we further provide the explicit dimensional-constraint under which the conclusion holds with certain stability and also in generic sense (e.g., Mas-Colell and Nachbar, 1991). However, it is worth noting that we just consider exogenous social-network effect rather than the endogenous formation of social networks discussed in Skyrms and Pemantle (2000), Bala and Goyal (2000) and Galeotti et al. (2006). To the best of our knowledge, the paper, for the first time, investigates the topology of mixed-strategy game equilibrium in general social networks.

Why do we focus on social-network effect? In the traditional approach of evolutionary game theory, individuals are usually assumed to meet at random and hence the well-known random-matching rule (e.g., Maynard Smith, 1982; Fudenberg and Levine, 1993; Ellison, 1994; Okuno-Fujiwara and Postlewaite, 1995; Weibull, 1995) is widely employed. In a well-mixed population, this methodology indeed provides us with an appropriate benchmark. Nonetheless, it is convincing to argue that people live in a highly structured society consists of groups, which implies that random matching will not always provide us with compelling approximation to reality when we are concerned with local interactions rather than uniform interactions among the players. In fact, Ellison (1993) shows that local interaction has very important and also different implications in equilibrium selection relative to that of uniform interaction or random matching. With the good purpose of correctly predicting the behavior of individuals, it is absolutely necessary to introduce social-network structure induced by non-uniform social interactions (see, Haag and Lagunoff, 2006; Horst and Scheinkman, 2006) into our games.

Indeed, many existing studies have been devoted to this issue. For example, noting that personal interactions among individuals are structured by families, neighborhoods, communities, and markets, as well as other formal and informal institutions, most of existing articles emphasize reputation effect and retaliation effect of the community (see, Kandori, 1992; Kahneman et al., 1986; Ghosh and Ray, 1996; Spagnolo, 1999; Anderson and Smith, 2010; Takahashi, 2010), while in the model of Bowles and Gintis (1998), the segmentation or segregation effect (e.g., Schelling, 1969, 1971) of the community is also explored. Undoubtedly, all of these effects can be regarded as specific examples of the general social-network effect discussed in the paper. Furthermore, individuals in the games also have preferences, motivations and emotions, that is, they have control over the frequency or duration of interactions. For instance, studies of dynamic social networks and theories on the evolution of cooperation in dynamically structured populations (e.g., Ohtsuki et al., 2007; Pacheco et al., 2008; Pacheco et al., 2006) usually construct models in which individuals differ in the rate at which they seek new interactions with others.

For the sake of simplicity, we have interpreted social-network effect in the sense of Skyrms and Pemantle (2000) that the frequencies individuals meet each other are modified by the existing social-network structure when compared to that of well-mixed populations. That is, in evolutionary sense, social network affects the game equilibrium through the

impact forced on the frequencies individuals meet each other and hence the payoffs individuals finally receive. And it is easily seen that our specification is without loss of generality. In our model, representative players are assumed to maximize the discounted payoffs subject to the belief-learning dynamics, and then the solutions, if exist, form the game equilibrium.

The main result reveals that, in many interesting and also important cases, one can hardly approximate the game equilibrium in social network via the game equilibrium of an ideal random-matching world. In other words, it is reasonable to argue that the game equilibrium in nontrivial social networks would be of independent interest. Moreover, it is illustrated that the game equilibrium is indeed injective map with respect to the social-network effect under consideration. What's the corresponding inspiration? Rather, we may interpret the result as that different social networks yield their independent interest if they produce different (in the sense of our specification in the model) social-network effects. In other words, the uniqueness of the mixed-strategy game equilibrium in a given social network is identified.

The paper is organized as follows. Section 2 presents the basic model. In section 3, we mainly analyze the social-network effect imposed on the game equilibrium defined and derived in section 2. And our major innovations appear in section 3. Section 4 concludes the paper with some remarks.

2. The Model

We study the social-network effect on game equilibrium in the context of two-player asymmetric normal-form games. Without great loss of generality, one may interpret our background in the evolutionary sense. That is, there are two heterogeneous groups of populations. In particular, there is a representative row-player with m strategies for the first population, while there is a representative column-player with n strategies available for the second group of population. Naturally, payoffs are determined by two matrices, A, which is $m \times n$, for the first population, and B, which is $n \times m$, for the second population.

Furthermore, suppose in period t there are M_i players who choose strategy i for $\forall i = 1,\ldots,m$, and also N_j players who choose strategy j for $\forall j = 1,\ldots,n$. Thus, we let $x_i := M_i / \Sigma M_k$ and $y_j := N_j / \Sigma N_l$ denote the frequencies of strategies i and j, respectively, for $\forall i = 1,\ldots,m$ and $\forall j = 1,\ldots,n$. Thus, applying the random matching rule in a well- mixed population, the average payoffs of strategy i and strategy j are given by $(Ay)_i$ and $(Bx)_j$, respectively, for $y := (y_1,\ldots,y_n)'$ and $x := (x_1,\ldots,x_m)'$ with " $'$ " denoting transpose. Clearly, we can put,

$$\Delta^{row} := \left\{ x \in \mathbb{R}^m \mid \sum_{i=1}^{m} x_i = 1 \text{ for } x_i \in [0,1],\ \forall i = 1,\ldots,m \right\}$$

$$\Delta^{column} := \left\{ y \in \mathbb{R}^n \text{ üþü} \sum_{j=1}^{n} y_j = \quad y_j \in [0,1],\ \forall j = 1,\ldots,n \right\}$$

It is especially worth emphasizing that x can be regarded as the vector of row-strategy distribution among the first population in the evolutionary sense on the one hand, it, on the other hand, can also be interpreted as the frequencies of the actions of the representative row-player. Similarly, we can consider the vector y in the same way. Thus, as in Hofbauer and Hopkins (2005), we formally give,

Definition 1 (Belief-learning dynamics in well-mixed populations)

The representative row-player's belief about the actions of the representative column-player is characterized by the following learning dynamics,

$$\dot{y} \in BR(x) - y$$

where $BR(x)$ is the set of all best responses of column-player to $x \in \Delta^{row}$. By symmetry, the representative column-player's belief about the actions of the representative row-player is determined by the learning dynamics as follows,

$$\dot{x} \in BR(y) - x$$

where $BR(y)$ is the set of all best-response actions of row-player to $y \in \Delta^{column}$.

Remark 2.1. As is pointed out by Hofbauer and Hopkins (2005), $BR(x)$ and $BR(y)$ are typically not functions but correspondences. Nevertheless, one may also consider some specific best-response functions, for example, the exponential or logit choice rule (see, Hofbauer and Sandholm, 2002),

$$BR_j(x) := \frac{\exp\left[\gamma^{-1}(Bx)_j\right]}{\sum_{l=1}^{n}\exp\left[\gamma^{-1}(Bx)_l\right]},\ j = 1,\ldots,n.$$

And similarly,

$$BR_i(y) := \frac{\exp\left[\xi^{-1}(Ay)_i\right]}{\sum_{k=1}^{m}\exp\left[\xi^{-1}(Ay)_k\right]},\ i = 1,\ldots,m.$$

where $\gamma, \xi \in (0,\infty)$ denote the noise levels, respectively. And when the noise level approaches zero, logit choice approaches unperturbed maximization; when the noise level approaches infinity, it approaches uniform randomization. Therefore, in well-mixed populations and for the present continuous-time repeated game, one can define,

Problem 1. The optimization problem facing the representative row-player is given by,

$$\max_{x\in\Delta^{row}}\int_0^{\infty} e^{-\rho t}\left(x\cdot Ay\right)dt$$

subject to,

$$\dot{y}\in BR\left(x\right)-y,\ y\in\Delta^{column}.$$

Problem 2. The optimization problem facing the representative column-player reads as follows,

$$\max_{x\in\Delta^{column}}\int_0^{\infty} e^{-\rho t}\left(y\cdot Bx\right)dt$$

subject to,

$$\dot{x}\in BR\left(y\right)-x, x\in\Delta^{row}.$$

As one can see, such kind of optimization problem may be involved in optimization subject to non-linear constraints, which hence implies that we generally cannot adopt the neo-classical optimization methodology and dual approach proposed in Ivanov and Dobreva (2010) for the studying of labor supply issues.

Definition 2 (Game equilibrium in a well-mixed population)

If Problem 1 and Problem 2 are solvable, then we denote the corresponding solutions by x_y^* and y_x^*, respectively. And hence, $\left(x_y^*, y_x^*\right)$ is called the game equilibrium in a well-mixed population.

Remark 2.2. Generally speaking, x_y^* can be regarded as a $C^r\left(r\geq 1\right)$ map with respect to y and y_x^* can be regarded as a $C^r\left(r\geq 1\right)$ map with respect to x.

In the above constructions, we just consider the ideal case of well-mixed populations. However, in reality, individuals live in a structured society. That is, there must exist social-network effect which indeed affects the payoffs of the players. In particular, in the current study we incorporate social-network effect by two vectors, $\beta:=\left(\beta_i\right)_{i=1,\ldots,m}$ and $\eta:=\left(\eta_j\right)_{j=1,\ldots,n}$ with,

$$\Gamma^{row}:=\left\{\beta\in\mathbb{R}^m \mid \sum_{i=1}^m\beta_i=0 \text{ for } \beta_i\in\left[-1,1\right],\ \forall i=1,\ldots,m\right\}$$

$$\Gamma^{column}:=\left\{\eta\in\mathbb{R}^n \mid \sum_{j=1}^n\eta_j=0 \text{ for } \eta_j\in\left[-1,1\right],\ \forall j=1,\ldots,n\right\}$$

denoting the corresponding domains, respectively. As you can see, we characterize the social-network effect from the perspective that social-network structure affects the

frequencies individuals meet each other in the underlying game. For example, in social interactions, people usually have much higher frequencies to interact with families and neighbors than the remaining people in a given community. What is more, individuals have higher frequencies to interact with people who live in the same community than the people live in any other remaining communities. So, any social-network structure produces the corresponding social-network effect either through the spatial factors such as communities and neighborhoods or based on social collections such as roommate relationship and friendship among the individuals. And these social phenomena sufficiently capture the intuition and essence of our definition of the social-network effect in the model.

Now, with the exogenous social-network effect defined above, the average payoffs of strategies i and j are respectively given by $\left(A\left(y+\eta\right)\right)_i$ and $\left(B\left(x+\beta\right)\right)_j$, for $i=1,\ldots,m$ and $j=1,\ldots,n$. We, by modifying Definition 1, give,

Definition 3 (Belief-learning dynamics in social networks)

The representative row-player's belief about the actions of the representative column-player is characterized by the following learning dynamics,

$$\dot{y}\in BR\left(x+\beta\right)-y$$

where $BR\left(x+\beta\right)$ is the set of all best responses of column-player to $x+\beta\in\Delta^{row}$ with $\beta\in\Gamma^{row}$. Correspondingly, the representative column-player's belief about the actions of the representative row-player is determined by the dynamics as follows,

$$\dot{x}\in BR\left(y+\eta\right)-x$$

where $BR\left(y+\eta\right)$ denotes the set of all best-response actions of the row-player to $y+\eta\in\Delta^{column}$ with $\eta\in\Gamma^{column}$.

Accordingly, provided the above preparations, we can give,

Problem 3. The optimization problem, modified by the social-network effect, facing the representative row-player is given by,

$$\max_{x\in\Delta^{row}}\int_0^{\infty}e^{-\rho t}\left[\left(x+\beta\right)\cdot A\left(y+\eta\right)\right]dt$$

subject to,

$$\begin{cases}\dot{y}\in BR\left(x+\beta\right)-y,\ \ y\in\Delta^{column}\\ y+\eta\in\Delta^{column},\ \eta\in\Gamma^{column}\\ x+\beta\in\Delta^{row},\ \beta\in\Gamma^{row}\end{cases}$$

Problem 4. The optimization problem facing the representative column-player in a social network reads as follows,

$$\max_{y\in\Delta^{column}} \int_0^{\infty} e^{-\rho t}\left[\left(y+\eta\right)\cdot \mathrm{B}\left(x+\beta\right)\right]dt$$

subject to,

$$\begin{cases} \dot{x}\in BR\left(y+\eta\right)-x, x\in\Delta^{row} \\ x+\beta\in\Delta^{row}, \beta\in\Gamma^{row} \\ y+\eta\in\Delta^{column}, \eta\in\Gamma^{column} \end{cases}$$

Definition 4 (Game equilibrium in a social network)

Provided Problem 3 and Problem 4 are solvable, we denote the corresponding solutions by $\hat{x}_y\left(\beta,\eta\right)$ and $\hat{y}_x\left(\eta,\beta\right)$, respectively. Thus, the pair $\left(\hat{x}_y\left(\beta,\eta\right),\hat{y}_x\left(\eta,\beta\right)\right)$ is named as the game equilibrium in a social network.

Remark 2.3. Without loss of generality, $\hat{x}$ can be regarded as a $C^r\left(r\geq 1\right)$ map with respect to y and also $\hat{y}$ can be seen as a $C^r\left(r\geq 1\right)$ map with respect to x based upon our constructions. Noting that the key issue of the current study is not the existence of game equilibrium defined above but the social-network effect imposed on the game equilibrium, we suppose throughout that the game equilibria exist with the corresponding $C^r\left(r\geq 1\right)$ properties fulfilled. And we leave the investigation of the open question about the existence of game equilibrium to future work.

Additionally, in order to verify that Definition 4 is actually well-defined we will introduce the following numerical example to reveal the corresponding desirability.

Example 1. Suppose that the payoff matrices have the following numerical characteristic,

$$A=\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix},\ B=\begin{pmatrix} 3 & 0 \\ 0 & 1 \end{pmatrix}$$

which shows that we are considering an asymmetric coordination game, i.e., a normal-form game that is widely used and applied in game theory and economic theory. Thus, for the representative row-player in Problem 3, we have,

$$\begin{aligned} &\left(x+\beta\right)\cdot A\left(y+\eta\right)=\left(x_1+\beta_1,1-x_1+\beta_2\right)\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}\begin{pmatrix} y_1+\eta_1 \\ y_2+\eta_2 \end{pmatrix}= \\ &=\left(x_1+\beta_1\right)\left(y_1+\eta_1\right)+2\left(1-x_1+\beta_2\right)\left(y_2+\eta_2\right) \end{aligned}$$

About the underlying belief-learning dynamics, we specifically choose the broadly employed logit choice rule that is introduced in Remark 2.1, i.e.,

$$BR_1(x+\beta)=\frac{\exp\left[\gamma^{-1}\left(B(x+\beta)\right)_1\right]}{\sum_{l=1}^{2}\exp\left[\gamma^{-1}\left(B(x+\beta)\right)_l\right]}=\frac{1}{1+\exp\left[\gamma^{-1}\left(1+\beta_2-3\beta_1-4x_1\right)\right]}$$

for $\gamma\in(0,\infty)$. In particular, we adopt the following learning process,

$$dy_1=\left(BR_1(x+\beta)-y_1\right)dt+\sigma_1 y_1 dW$$

where W denotes a standard Brownian motion, i.e., we consider the case of stochastic learning dynamics driven by stochastic replicator dynamics. Hence, the optimization problem facing the representative row-player can be written as follows,

$$\max_{0\le x_1\le 1}\int_0^{\infty}e^{-\rho t}\left[\left(x_1+\beta_1\right)\left(y_1+\eta_1\right)+2\left(1-x_1+\beta_2\right)\left(1-y_1+\eta_2\right)\right]dt$$

subject to,

$$dy_1=\left(\frac{1}{1+\exp\left[\gamma^{-1}\left(1+\beta_2-3\beta_1-4x_1\right)\right]}-y_1\right)dt+\sigma_1 y_1 dW$$

The corresponding Bellman equation can be expressed as follows,

$$\begin{aligned}&\rho J(y_1)-\frac{1}{2}\sigma_1^2 y_1^2 J''(y_1)=\\&=\max_{0\le x_1\le 1}\left\{\left[\left(x_1+\beta_1\right)\left(y_1+\eta_1\right)+2\left(1-x_1+\beta_2\right)\left(1-y_1+\eta_2\right)\right]+\right.\\&\left.+J'(y_1)\left(\frac{1}{1+\exp\left[\gamma^{-1}\left(1+\beta_2-3\beta_1-4x_1\right)\right]}-y_1\right)\right\}\end{aligned}$$

with $J(y_1)$ representing the value function, which is a $C^r\left(r\ge 1\right)$ map in this formulation. Therefore, optimal choice of x_1 is determined by the following first-order condition,

$$\left(y_1+\eta_1\right)-2\left(1-y_1+\eta_2\right)+J'(y_1)\frac{4\gamma^{-1}\exp\left[\gamma^{-1}\left(1+\beta_2-3\beta_1-4x_1\right)\right]}{\left(1+\exp\left[\gamma^{-1}\left(1+\beta_2-3\beta_1-4x_1\right)\right]\right)^2}=0$$

which is equivalent to the following equation,

$$\frac{\exp\left[\gamma^{-1}\left(1+\beta_2-3\beta_1-4x_1\right)\right]}{\left(1+\exp\left[\gamma^{-1}\left(1+\beta_2-3\beta_1-4x_1\right)\right]\right)^2}=\frac{\gamma\left[2\left(y_2+\eta_2\right)-\left(y_1+\eta_1\right)\right]}{4J'(y_1)}$$

which implies that $\hat{x}$ is indeed a $C^r\left(r \geq 1\right)$ map with respect to y and it can be expressed as $\hat{x}_y\left(\beta,\eta\right)$. Similarly, one can also demonstrate that $\hat{y}_x\left(\eta,\beta\right)$ is indeed a $C^r\left(r \geq 1\right)$ map with respect to x. And we leave the details to the interested reader. To summarize, game equilibrium in Definition 4 is well-defined and the existence of such kind of game equilibrium endogenously affected by social networks is confirmed in such a numerical example.

3. Social-Network Effect

Based on Definition 2 and Definition 4, we give,

$$f_y\left(\beta,\eta;x_y^*\right) := \hat{x}_y\left(\beta,\eta\right) - x_y^*$$

which is a $C^r\left(r \geq 1\right)$ map with respect to its arguments based upon our specifications.

Assumption 1. $0 \leq \dim\Gamma^{row} + \dim\Gamma^{column} < \dim\Delta^{row}$.

From Assumption 1 and also the following assumptions, one can easily find that the present model mainly focuses on mixed-strategy equilibrium emphasized by the seminal papers of Harsanyi (1973) and Fudenberg and Kreps (1993), and among others.

Transversality will be sufficiently used in the following proof. About the definition of transversality, one can refer to Marsden et al. (2001, pp. 179), and one can refer to Hirsch (1976, pp. 74) about the Transversality Theorem and refer to Hirsch (1976, pp. 79-80) about the Parametric Transversality Theorem. Moreover, about Preimage Theorem, one can refer to Guillemin and Pollack (1974, pp. 21). And we bring the idea employed by Citanna and Siconolfi (2010) to our major proof.

Proposition 1

Let $y \in \Delta^{column}$ be given. Thus, there is an open and dense subset Δ^{row*} of Δ^{row} such that the system $f_y\left(\beta,\eta;x_y^*\right) = 0$ does not have a solution in the space $\Gamma^{row} \times \Gamma^{column}$ for all $x_y^* \in \Delta^{row*}$ when Assumption 1 holds.

Proof:

For $x_y^* \in \Delta^{row}$, $f_{y,x_y^*} : \Gamma^{row} \times \Gamma^{column} \to \Delta^{row}$, where we, by Assumption 1, have $\dim\Gamma^{row} + \dim\Gamma^{column} < \dim\Delta^{row}$, and thus there are fewer unknowns than equations. The Jacobian of the map $f_y\left(\cdot\right)$ with respect to $x_y^* = \left(x_{yi}^*\right)_{i=1,\ldots,m}$ is equal to the negative identity matrix. Hence, $\text{rank}Jf_y = \dim\Delta^{row}$, which implies that $f_y\left(\cdot\right)$ is a $C^r\left(r \geq 1\right)$ submersion. Now, applying the definition of Transversality produces $f_y \pitchfork S$ for $\forall S \subset \Delta^{row}$. Therefore, Parametric Transversality Theorem implies that for $x_y^* \in \ddot{A}^{row*}$, a dense subset of Δ^{row}, $f_{y,x_y^*} \pitchfork S$ for $\forall S \subset \Delta^{row}$. By Assumption 1, we get $\dim\Gamma^{row} + \dim\Gamma^{column} + \dim\{0\} < \dim\Delta^{row}$, thus we get $f_{y,x_y^*}\left(\Gamma^{row} \times \Gamma^{column}\right) \bigcap \{0\} = \varnothing$ for $\forall y \in \Delta^{column}$ and $x_y^* \in \Delta^{row*}$ by using the

definition of Transversality again. Accordingly, $f_y\left(\beta,\eta;x_y^*\right):=\hat{x}_y\left(\beta,\eta\right)-x_y^*=0$ does not have a solution in the compact product-space $\Gamma^{row}\times\Gamma^{column}$ for $\forall y\in\Delta^{column}$ and $x_y^*\in\Delta^{row*}$. Moreover, we proceed to show that Δ^{row*} is also open. Notice that $\{0\}$ is a closed subset provided the usual topology on the simplex Δ^{row}, and also the map $f_y\left(\cdot\right)$ is $C^r\left(r\geq 1\right)$, an application of the Parametric Transversality Theorem produces the required assertion. ■

Similarly, given,

Assumption 2. $0\leq \dim\Gamma^{row}+\dim\Gamma^{column}<\dim\Delta^{column}$.

We derive the following proposition,

Proposition 2

Let $x\in\Delta^{row}$ be given. Thus, there is an open and dense subset $\Delta^{column*}$ of Δ^{column} such that the system $g_x\left(\eta,\beta;y_x^*\right):=\hat{y}_x\left(\eta,\beta\right)-y_x^*=0$ does not have a solution in the space $\Gamma^{column}\times\Gamma^{row}$ for all $y_x^*\in\Delta^{column*}$ when Assumption 2 holds.

Proof:

It is easily seen that the proof is quite similar to that of Proposition 1, thus we omit it. ♦

Definition 5 (Independence of game equilibrium)

We mean independence of game equilibrium in social networks in the following sense: the corresponding game equilibrium essentially changes when a non-trivial social-network structure is imposed on the underlying well-mixed population. That is, independence of game equilibrium in social networks implies that we can hardly approximate the game equilibrium in social networks through that relatively easily derived in well-mixed populations and this definition of independence has nothing to do with that of probabilistic independence.

To summarize, we can establish,

Theorem 1 (Independence)

Provided the above constructions, social-network effect indeed generates nontrivial differences among the resulting mixed-strategy game equilibria when the corresponding dimensional constraints in Assumption 1 and Assumption 2 are fulfilled.

Remark 3.1. Theorem 1 implies that, for some important and also interesting cases, one can hardly approximate the game equilibrium in social networks via that in a well-mixed population by using the random-matching rule. Although the methodology of random matching (e.g., Gilboa and Matsui, 1992; Aliprantis et al., 2007, and among others) indeed plays a crucial role in equilibrium selection of (evolutionary) game theory,

it would probably provide us with wrong or biased predictions about the equilibrium behaviors of individuals in many important and also interesting social networks discussed in Theorem 1. For example, we may conjecture that the equilibrium derived by random-matching mechanism in well-mixed populations cannot approach the equilibrium in social networks even when the corresponding social network approaches the state of well-mixed population provided the social-network effect defined above vanishes. In other words, the game equilibrium in social networks should be of independent interest. Moreover, this result holds with certain stability and also in generic sense thanks to the well-known Transversality Theorem.

Now, we are encouraged to consider the following $C^r\left(r \geq 1\right)$ map,

$$\varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right) := \hat{x}^1\left(\beta^1,\eta^1;y\right) - \hat{x}^2\left(\beta^2,\eta^2;y\right)$$

for the game equilibria $\hat{x}^1\left(\cdot\right),\hat{x}^2\left(\cdot\right) \in \Delta^{row}$ from Definition 4 and any action $y \in \Delta^{column}$. And we introduce the following assumption,

Assumption 3. $2\left(\dim\Gamma^{row} + \dim\Gamma^{column}\right) < \dim\Delta^{row}$.

Proposition 3

Based upon Assumption 3 and the above specifications, there is an open and dense subset $\hat{\Delta}^{column}$ of Δ^{column} such that the system $\varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)=0$ does not have a solution in the set,

$$\grave{\mathrm{U}} := \left\{\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \Gamma^{row}\times\Gamma^{column}\times\Gamma^{row}\times\Gamma^{column} \mid\mid\mid \left(\beta^1,\eta^1\right)-\left(\beta^2,\eta^2\right)\mid\mid \neq 0\right\}$$

for $\forall y \in \hat{\Delta}^{column}$ when the derivative of the map φ with respect to y is surjective.

Proof:

We first put,

$$\Omega := \left\{\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \Gamma^{row}\times\Gamma^{column}\times\Gamma^{row}\times\Gamma^{column} \mid\mid\mid \left(\beta^1,\eta^1\right)-\left(\beta^2,\eta^2\right)\mid\mid \neq 0\right\}$$

And for any integer $k>0$, let,

$$\Omega_k := \left\{\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \Gamma^{row}\times\Gamma^{column}\times\Gamma^{row}\times\Gamma^{column} \mid\mid\mid \left(\beta^1,\eta^1\right)-\left(\beta^2,\eta^2\right)\mid\mid \geq \frac{1}{k}\right\}$$

Obviously, $\Omega_k \subset \Omega$, and both Ω_k and Ω are sets that are (locally) independent of $y \in \Delta^{column}$. Let $\Delta^{column}\left(k\right)$ denote the subset of Δ^{column} where the system $\varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)=0$ does not have a solution in Ω_k. If $\Delta^{column}\left(k\right)$ is open and dense in Δ^{column}, then we obtain,

$$\hat{\Delta}^{column} := \bigcap_{k>0} \Delta^{column}(k)$$

which is the intersection of a countable family of open and dense sets; therefore, it is a residual and therefore dense subset of Δ^{column} by applying Baire Category Theorem. And also, the system $\varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)=0$ does not have a solution in $\mathrm{cl}\Omega$, i.e., the closure of the set Ω, for $\forall y \in \hat{\Delta}^{column}$. Suppose not, then there is $y \in \hat{\Delta}^{column}$ and $\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \mathrm{cl}\Omega$ such that $\varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)=0$. By the definition of the space Ω, there must exist $\tilde{k}>0$ such that $\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \Omega_{\tilde{k}}$. However, the latter implies that $y \notin \Delta^{column}\left(\tilde{k}\right)$, a contradiction.

The compactness of Ω_k implies that $\| \varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)\| \geq \zeta$ for some $\zeta>0$ and all $\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \Omega_k$. However, the map $\varphi(\cdot)$ is continuous in all its arguments and hence $\| \varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)\| > 0$ for all $\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \Omega_k$ and $\breve{y}$ in an open neighborhood of y. Therefore, it is confirmed that the set $\Delta^{column}(k)$ is open.

Now, we are in the position to show that $\Delta^{column}(k)$ is also dense. It follows from Assumption 3 that $\dim\Omega_k < \dim\Delta^{row}$, and thus there are more equations than unknowns in the system $\varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)=0$ for any given $y \in \Delta^{column}$. Consequently, by the Preimage Theorem and Parametric Transversality Theorem, there is a dense subset $\Delta^{column}(k)$ of Δ^{column} where $\varphi\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right);y\right)=0$ has no solution in Ω_k due to the assumption that the derivative of the map φ with respect to y is surjective. So, the proof is completed. ■

Remark 3.2. Here, the metric or norm $\|\cdot\|$ is the canonical metric in $\mathbb{R}^k$.

Assumption 4. $2\left(\dim\Gamma^{row}+\dim\Gamma^{column}\right) < \dim\Delta^{column}$.

Proposition 4

Based upon Assumption 4 and the above specifications, there is an open and dense subset $\hat{\Delta}^{row}$ of Δ^{row} such that the system $\psi\left(\left(\eta^1,\beta^1\right),\left(\eta^2,\beta^2\right);x\right) := \hat{y}^1\left(\eta^1,\beta^1;x\right)-\hat{y}^2\left(\eta^2,\beta^2;x\right)=0$ does not have a solution in the set

$$\Omega := \left\{\left(\left(\beta^1,\eta^1\right),\left(\beta^2,\eta^2\right)\right) \in \Gamma^{row}\times\Gamma^{column}\times\Gamma^{row}\times\Gamma^{column} \;|\|\left(\beta^1,\eta^1\right)-\left(\beta^2,\eta^2\right)\| \neq 0\right\}$$

for $\forall x \in \hat{\Delta}^{row}$ when the derivative of the map ψ with respect to x is surjective.

Proof:

One can easily notice that the proof is quite similar to that of Proposition 3, we take it as omitted and leave it to the interested reader. ♦

Definition 6 (Uniqueness of game equilibrium)

We discuss uniqueness of game equilibrium in a given social network. For a given social network, the corresponding game equilibrium is a map of the underlying social-network effect (or social-network structure). If different social-network effects lead to different game equilibria or equivalently the same game equilibrium implies that there exists the same social-network effect, we get the game equilibrium as an injective map of the social-network effect. As a result, injection means uniqueness of the game equilibrium in a given social network.

Theorem 2 (Uniqueness)

The game equilibrium given in Definition 4 is injective with respect to the social-network effect when either Proposition 3 or Proposition 4 holds. This yields that different social-network effects produce effective differences among the resulting game equilibria when the corresponding dimensional constraints are satisfied. Thus, naturally, there exists a one-to-one correspondence between the social-network structure and the mixed-strategy equilibrium. That is to say, the uniqueness of the mixed-strategy game equilibrium in a given social network is identified.

Remark 3.3. It is especially worth noting that the above result holds with certain stability and also in generic sense owing to the Transversality Theorem. By this theorem, one can conclude that different social networks would be of independent interest if they indeed produce different social-network effects in the sense of our specification. To sum up, social-network mechanism provides a unique prediction of the equilibrium behaviors of the individuals involved in the underlying game.

Corollary 1

The property Uniqueness in Theorem 2 implies the property Independence established in Theorem 1.

Proof:

It is easily seen that Assumption 3 implies Assumption 1 and also Assumption 4 implies Assumption 2, which accordingly yields the required result. ♦

Remark 3.4. This observation also demonstrates the inherent consistency of the underlying model specification. Notice that the above assumptions have provided the minimum requirements of the corresponding dimensional constraints of properties Independence and Uniqueness, we have thus shown the biggest sets of social networks in which Independence and Uniqueness hold true, respectively.

4. Conclusion

In current study, topological analyses about the social-network effect on game equilibrium have been thoroughly provided. It would be very interesting to explore the game equilibrium in social networks rather than well-mixed populations (see, Weibull, 1995; Hofbauer and Sigmund, 2003, and among others), and the paper provides a simple and general framework for this issue. Nevertheless, we just study exogenous social-network effect in the sense of Skyrms and Pemantle (2000) in the present limited model. Moreover, the paper mainly focuses on mixed-strategy equilibrium emphasized by the seminal papers of Harsanyi (1973) and Fudenberg and Kreps (1993).

Two major conclusions are established in the model. Firstly, generally speaking, nontrivial social network induces game equilibrium strictly different from that in well-mixed populations. Secondly, it is interesting to find that the game equilibrium exhibits injective property with respect to the social-network effect under consideration. That is, we have proved the uniqueness of mixed-strategy game equilibrium in a given social network. Therefore, we argue that the game equilibrium in social networks would be of independent interest and random-matching rule (see, Ellison, 1994; Okuno-Fujiwara and Postlewaite, 1995; Weibull, 1995; Hofbauer and Sigmund, 2003, and among others) cannot always provide us with a compelling approximation. Finally, it is shown that uniqueness implies independence for a wide range of social networks. And we have even derived the biggest sets of social networks in which independence and uniqueness hold true, respectively, in the underlying game.

What are the economic implications of the main results established in the paper? On the one hand, even though the theory of game equilibrium in well-mixed populations has been thoroughly established in the past several decades and the importance of social-network effect imposed on game equilibria and economic outcomes has been sufficiently emphasized in recent studies, there still is not a general conclusion regarding the internal relation between the both. The paper demonstrates an impossibility theorem by confirming the independence of game equilibrium in social networks. This impossibility theorem argues that we can hardly predict the equilibrium behaviors in social networks when we only have information about the original well-mixed populations. That is to say, since the players choose their best strategies based on the information of the game context, our result implies that social-network structures produce relevant information that is essential in determining equilibrium behaviors. Rather, one may even argue that game equilibria in social networks are of independent interest mainly because social networks themselves produce informational frictions facing the players when compared to the original well-mixed world. On the other hand, uniqueness of game equilibrium in a given social network not only leads us to the corresponding independence of game equilibrium but also makes things much easier when evaluating economic welfare of different social networks. Noting that we can comparatively easily Pareto rank different game equilibrium according to the corresponding payoffs, we can thus Pareto rank different social networks by applying the uniqueness property. As is well known, social networks are usually formed by social

norms, conventions and\or institutions. Consequently, one can directly Pareto rank different social norms or institutions based upon our general result. In particular, we have to some extent modeled the underlying idea of Coase (1988) that we need a baseline framework to comparatively and sufficiently evaluate the economic efficiency of different institutional arrangements in order to make a wise choice during the corresponding institutional changes in reality.

As a final point, I'd like to cite some examples in existing articles to make our general arguments much more intuitive. First, the simple model constructed in Dai and Cheng (2011) can be regarded as a special application of the Independence property demonstrated in this paper. As is widely known, (Defect, Defect) is the unique Nash equilibrium and evolutionary stable equilibrium (ESE) of Prisoner's Dilemma in a well-mixed population (see, Weibull, 1995; Hofbauer and Sigmund, 2003, and among others). However, Dai and Cheng (2011) prove that there is a non-random matching mechanism, which naturally corresponds to a special type of social-network structure (or effect), such that (Cooperate, Cooperate) is the unique induced game equilibrium. That is to say, social-network effect does make sense and game equilibria in some social networks are of independent interest relative to those in well-mixed populations. Second, as is emphasized above, Uniqueness not only implies Independence but also yields interesting economic-welfare implications. Dai (2012) indeed reveals a general existence of the Pareto-optimal social-network structure in any given evolutionary normal-form game. Moreover, in a much simpler example, Dai and Cheng (2011) prove that there exists an optimal and stable level of social segmentation, which also results in a special type of social network, so that the welfare of the community is maximized under the background of Prisoner's Dilemma. Notice that Dai and Cheng (2011), and Dai (2012) only confirm the existence of Pareto-optimal social networks in evolutionary normal-form games, the present paper further demonstrates the underlying Uniqueness property, thereby making the Pareto ranking of different social networks much easier in large and general normal-form games. As a consequence, what are the corresponding lessons we have learned from this paper? On the one hand, like rational principle, evolutionary selection and learning mechanism, we can similarly use social-network effect as an effective equilibrium-selection mechanism especially when there are multiple equilibria in many social games or spatial games. On the other hand, the general result established in the paper also shows that we can design a unique social-network structure through formal social institutions or informal social norms to induce the Pareto-optimal game equilibrium of structured populations in real-world economies.

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Determinants of Tax Evasion in Ghana: 1970-2010

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Abstract

This paper investigates the factors that determine tax evasion in Ghana using time series data covering the period 1970-2010. Employing the currency demand approach, we obtained the estimates of the shadow economy and the level of tax evasion for the entire period. Using the bounds test technique of cointegration we found that the variables included in our ARDL model are bounded together. The short-run model indicates that per capita income, the average tax rate, age and inflation were positively and significantly associated with tax evasion while gender showed an inverse and significant relationship with tax evasion. The error correction term was negative, statistically significant and suggests that 45 per cent of the deviation from equilibrium tax evasion is corrected each year. In addition, the Granger causality test indicates that tax and inflation rates aid in predicting future levels of tax evasion in Ghana. The paper further discusses the policy implications of the findings.

Keywords: tax evasion, bounds testing, error correction, granger causality, Ghana

JEL Classification: H26; H41; O23

1. Introduction

Taxation plays an important role in economic development by sustaining the existence of the state and financing both social programmes and infrastructure investment. It also aids in the allocation of resources, redistribution of income, and correction of negative externalities as well as protection of domestic industries by restricting imports. The provision of public services and infrastructure financed by tax revenue is a key factor for economic growth and development. Yet, many developing countries fail to generate the requisite tax revenue to finance their public expenditures (Fuest and Riedel, 2009; Adamopoulos, 2010).

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Like many developing countries, Ghana depends heavily on taxes to generate the much needed revenue for development. Hence, in an attempt to reduce the complexity of the tax system in order to enhance efficiency, minimize the underground economy, discourage tax evasion and generate sufficient revenue, Ghana's tax system has undergone several structural reforms since the past three decades. In 1983, the initial tax reform measure of the fiscal adjustment programme was designed largely to restore the tax base which had been battered by the constant over-valuation of the domestic currency. This measure was expected to broaden the tax net, lower the tax burden on economic agents and reduce tax evasion. The reform also included the strengthening of production incentives with the introduction of an Investment Code (PNDC Law 116, 1985) and a new Minerals Law (Minerals Commission Law, 1986). This code identified four sectors-tourism, manufacturing, construction and building and agriculture as targeted sectors of investment. The code also provided a wide range of tax incentives and benefits to foreign and domestic investors with enterprises engaging in activities in any of the four areas. The introduction of the Value Added Tax in 1995, which cut across a wide range of commodities, was expected to minimize changes in the behaviour of economic agents.

The administrative reform of 1985 also focused on measures to enhance the efficiency of the tax administration and improve upon the equity of the tax system. A major component of this reform was the conversion of the Internal Revenue Service (IRS) and Customs, Excise and Preventive Service (CEPS) into the Ghana Revenue Authority, an autonomous corporate body with new organizational structures (GRA) in 2009. Its objective is to strengthen the role of the revenue institutions in achieving increased revenue collection and changing the structure of the tax system to make it more efficient and equitable. In 2007, the tax administration management information system was computerized and a unique identification number assigned to taxpayers for easy tracking by tax collectors. In addition, there has been gradual reduction of tax rates and elimination of multiple tax rates to reduce the distortions that arise from such tax systems. The introduction of the e-government project in November 2011 is aimed at linking Ghana Revenue Authority (GRA) to the Registrar General's Department (RGD) electronically to ensure GRA has access to the database of registered businesses for easy tracking and collection of tax payments.

In spite of the several fiscal reforms implemented to minimize tax burden and discourage activities of the underground economy, tax evasion continues to be a problem in Ghana. The presence of a large shadow economy implies activities which are liable to tax payments are hidden from the tax authorities and the related tax revenues are not collected. Tax evasion[1] thus reduces government revenue, increases the taxes that compliant taxpayers face and often reduces the public services that citizens receive. It also causes distortions in the economy which influence policy makers to make misinformed decisions. Hence, this

[1] Tax evasion is a situation where individuals or business entities decide not to fully honour their tax obligations through non-declaration or under declaration of taxable economic activities. It is an illegal act and it's also different from tax avoidance. Tax avoidance takes place when a tax payer makes use of the available loopholes and ambiguities in the tax system to lower his tax burden, but does not violate the tax law.

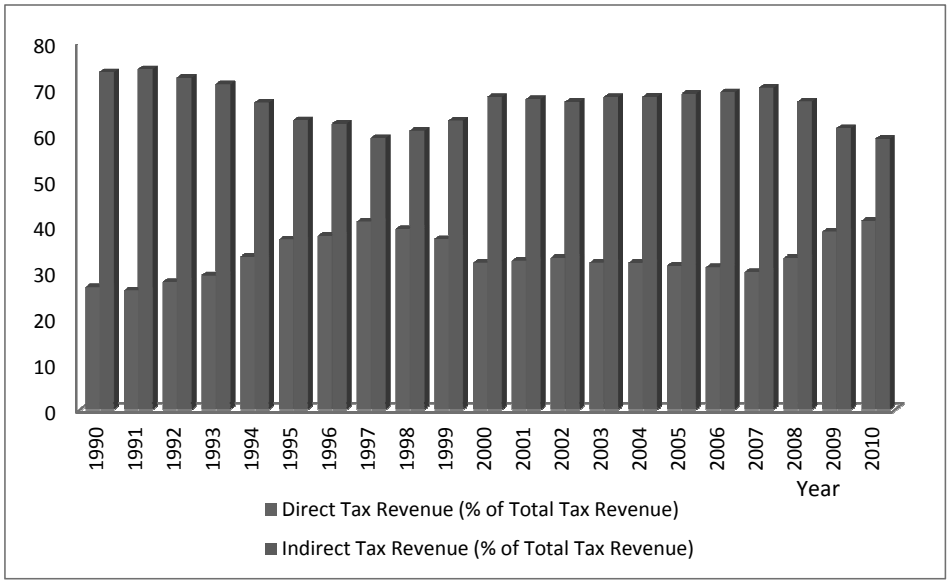
paper seeks to primarily identify the determinants of tax evasion in Ghana for the period 1970-2010.

The significance of the study is predicated upon the fact that a clear understanding of the extent of tax revenue left uncollected and the factors accounting for its existence is necessary for effective policy formulation and implementation in order to minimize tax evasion. Findings from this study is also expected to complement the body of existing literature on the subject matter especially on developing economies since most empirical studies on the determinants of tax evasion focus on developed economies (Clotfelter, 1983; Klovland, 1984; Crane and Nourzad, 1986; Trehub and Krasnikova, 2005; Richardson, 2006, 2008 and Schneider et al., 2008) with a limited number focused on developing countries[2].

1.1 Tax Revenue Performance (1990-2010)

The implementation of the Economic Recovery Programme (ERP) in 1983 rejuvenated several sectors of the economy from their deteriorating states. In fact, the tax revenue to GDP ratio in 1989 was almost three times what was realized in 1983 (Mishra, 2011). Figures 1 and 2 respectively show the trend of direct and indirect tax contributions to tax revenue and importantly, the share of tax revenue in GDP over the 1990-2010 periods.

Figure 1: Contributions of Direct and Indirect Taxes to Tax Revenue (1990-2010)



Source: Ghana Revenue Authority and author's computation

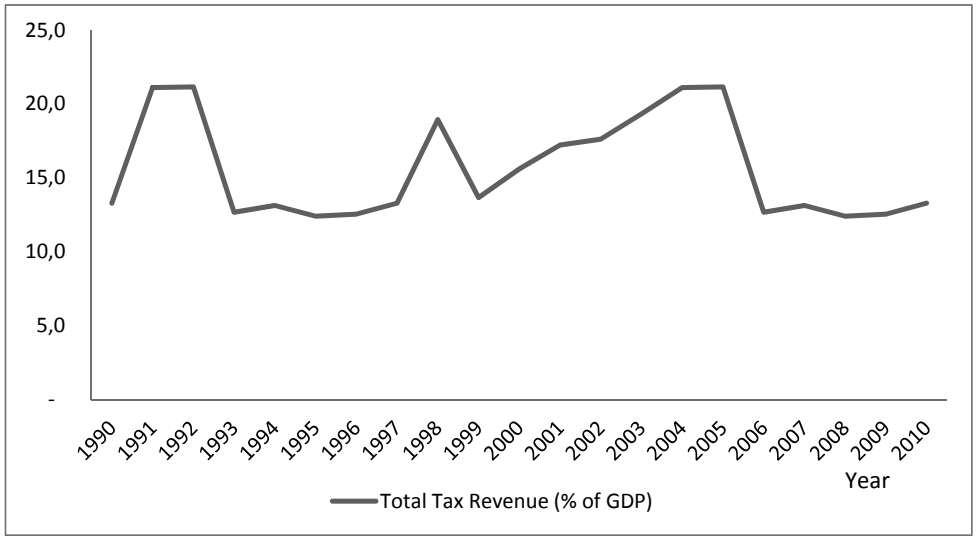
[2] The empirical studies conducted in Africa to examine the determinants of tax evasion include studies such as Ghura (1998), Faal (2003) and, Sookram and Watson (2005).

Figure 1 indicates that, indirect taxes contributed almost two-thirds of the tax revenue mobilized. This result could be attributed the relatively larger tax base of indirect taxes. Direct tax revenue relative to total tax revenue rose from 26.6 per cent in 1990 to 41.1 per cent in 2010, averaging 33.4 per cent for the period. In the same period, the share of indirect taxes in total tax revenue declined from 73.4 per cent to 58.9 per cent. Moreover, tax revenue to GDP rose from 12.5 per cent in 1990 to 13.3 per cent in 2010 and with an average of 16.5 per cent for the period.

In 1992, the then PNDC government (now the NDC) for the first time contested elections under the new constitution of the Fourth Republic. Uncertain of its victory, the government raised its spending from 19 per cent of GDP in 1991 to 25 per cent in 1992 (Leite et al., 2000; Farajova, 2011; Eyasi and Rahimi, 2012). With a roughly flat revenue ratio, a large deterioration in the budget occurred. A deficit equivalent to over 5 per cent of GDP was experienced in 1992 (Killick, 2010, Georgantopoulos and Tsamis, 2012). The excessive spending pattern of the government repeated itself in 1996 as it was also an election year. Attempts made to restore fiscal discipline were unable to rectify what had become the government's constant penchant to spend well in excess of its revenue.

In order to finance the deficits, government resorted to domestic borrowing. Given the narrowness of the domestic financial markets at that period, this resulted in crowding-out of private domestic investors engaged in production, exports and imports. Tax receipts from indirect taxes declined from 72.2 per cent of total tax revenue in 1992 to 62.9 per cent in 1999 (Figure 1). Within the same period, direct tax revenue relative to total tax revenue experienced a gradual increase that could be attributed to changes in the tax rate structure. The increase in total tax revenue to GDP ratio from 11 per cent in 1992 to 23.5 per cent in 1995 was as a result of the rise in revenue from direct taxes.

Figure 2: Tax Revenue as a percentage of GDP (1990-2010)



Source: Ghana Revenue Authority and author's calculation

In 2000, the government offered what they termed an "entrepreneur-led pattern of economic development". The whole machinery of the government was aimed at supporting both domestic and foreign investors in Ghana to increase their production and improve their competitiveness. An important feature of this policy was a swift rise in credit to the private sector, both in absolute and relative terms. Another significant aspect of the improved investment environment was a marked strengthening of macroeconomic conditions such as the decline in the fiscal deficit from 10 per cent of GDP in 2000 to 7 per cent in 2007 (Feridun and Sissoko, 2011). Furthermore, the ratio of indirect tax revenue to total tax revenue increased from 62.9 per cent in 1999 to 70.1 per cent in 2007 (Figure 1). Direct taxes share in tax revenue increased in 2008 to 33 per cent and further to 41.1 per cent in 2010. Over the same period, the contribution of indirect taxes to tax revenue declined from 67.03 per cent to 58.9 per cent. This decline could be attributed to the introduction of the communication services tax which is levied on communication service users, with imported communication devices being exempt from the tax (Diakomihalis, 2012).

The rest of this paper is organized as follows: section 2 focuses on the theoretical and empirical literature whereas section 3 deals with the methodology and model for the study. Section 4 is devoted to the presentation and discussion of the empirical results. The conclusion and policy recommendations are presented in section 5.

2. Literature Review

In a paper prepared for the International Economic Association Workshop on Economic Theory, Mirrles (1971) suggests tax evasion as a topic for theoretical investigation. This provides Allingham and Sandmo (1972) with the motivation to review income tax evasion in their article "Income Tax Evasion: A Theoretical Analysis". The objective of that paper was to analyze the decision to evade or not to evade by a taxpayer and the extent to which taxes are evaded by intentional underreporting. The behaviour of the taxpayer was assumed to conform to the Von Neumann-Morgenstern axioms for behaviour under uncertainty. In general, the models suggest that tax evasion is increasing in tax rate but decreasing in detection risk and penalty levels. However, the relationship between the amount of income reported and the actual income of the taxpayer is ambiguous. The approach on the one hand, is based on Becker's (1968) study on economics of criminal activity. On the other hand, it relates to the work by Arrow (1970), analyzing the optimal portfolio and insurance policies in economics of uncertainty[3].

Yitzhaki (1974) presents another version of the model of tax evasion. In his model, the fine paid by a taxpayer caught evading is levied on the amount of tax payments evaded rather than on the amount of undeclared income. In analysing the relationship between the four variables of interest in the model and the fraction of actual income reported, the comparative static results show a positive relation between both the probability of detection, the penalty rate and the amount of income reported. Considering the tax rate and the actual

[3] See also Dritsakis, and Gkanas (2009)

income, Yitzhaki resolves the ambiguities present in the previous model[4]. By making use of the assumption of decreasing absolute risk aversion, he arrives at a clear-cut hypothesis on the effect of the two parameters on the fraction of income reported. The author further explains that higher tax rates will lead to higher income declaration, thus a reduction in tax evasion. This result highly contradicts the general belief that high tax rates stimulate tax evasion (Adreoni, Erard and Feinsten, 1998).

A number of empirical studies have also been conducted to ascertain the determinants of tax evasion. While some authors focus on economic factors others also use non-economic factors such as demographic and behavioural factors to explain the phenomenon.

Tanzi (1983) was the first to econometrically estimate a currency demand function for the United States for the period 1929 to 1980 as way of formally estimating the shadow economy and hence tax evasion. His approach suggests that within the shadow economy, transactions are mainly conducted with cash payments, in order not to leave behind any evident for monetary authorities to trace. An increase in the size of the shadow economy therefore indicates an increase in the demand for currency. Other studies that employ Tanzi's currency demand equation include Klovland (1984), Hersoug (1983) and Sookram and Watson (2005).

Adopting Tobit, OLS, Random and Fixed effects techniques to estimate the tax evasion model, Trehub and Krasnikova (2005) reveal that the estimated cofficients for the variable capturing the size of the household is positive and statistically significant in all four estimation techniques. The explanation is that members of a large household tend to be more risk-averse than those of small households. Secondly, the result for the Tobit estimation alone indicates a significant and positive relationship between gender and tax evasion. Trehub and Krasnikova suggest that women in Russia are more likely to evade taxes than their male counterparts. Considering the relationship between income source and tax evasion, incomes from both government and rent exhibit a significant and negative relationship with tax evasion. The authors confirm the belief that households with incomes from government sources have less incentive to underreport their incomes. Finally, testing the effect of income and the personal income tax reform on the level of underreporting, the study shows that for all four estimation techniques, the estimated coefficients of income is statistically significant and positive.

Hofstede (1980) segregates culture into four dimensions (power distance, uncertainty avoidance, masculinity and individualism) and develops a country-based ranking for each dimension. Employing Hofstede's dimension of culture, Tsakumis et al. (2007) investigate the relation between national cultural dimensions and tax evasion for 50 countries. The authors adopt estimates of the shadow economy and measure tax evasion as a ratio of the size of a country's shadow economy to its GDP. Controlling for economic development, the OLS estimation results show a positive and significant relation between uncertainty-avoidance and tax evasion. The estimated coefficients for both individualism and masculinity give a positive and significant effect on tax evasion. In contrast, power distance shows

[4] Tax evasion model by Allingham and Sandmo (1972)

a significant and negative relation with tax evasion. The authors conclude that at higher levels of uncertainity avoidance and power distance, and lower levels of individualism and masculinity, tax evasion is on a higher scale across countries.

Schneider et al. (2008) analysed the long-run charateristics of tax rates and tax evasion in Italy over the period 1980-2004. Defining two different tax rates, they realise that the effective tax burden (revenue-net GDP ratio) is higher than the apparent tax burden (revenue-GDP ratio). Also, the difference between the two tax rates is a fixed value around 11 per cent but with short-run exogenous disturbances. Schneider et al. (2008) further explain that taxpayers always implement plans targetted at sustaining the equilibrium gap. Secondly, adopting cointegration technique, it was found that the apparent tax rate and tax evasion Granger-cause each other with a percentage change in the apparent tax rate increasing tax evasion by 0.48 per cent whereas an increase in the latter pushes the former up by 0.3 per cent. The authors conclude that in the long-run the apparent tax rate emerges as the determinant of tax evasion.

Extending the international tax evasion model by Tsakumis et al. (2007) by including legal, political and religious variables, Richardson (2008) tests the relationship between culture and tax evasion across 47 selected countries. Obtaining average data for the years 2002-2004 for both the dependent and independent variables from the Global competitiveness Report and controlling for economic development, the OLS regression results show that at higher levels of uncertainty avoidance, the level of tax evasion is higher across countries. In addition, the lower the level of religiousity, legal enforcement, trust in government and individualism, the higher the level of tax evasion.

3. Methodology and Model

3.1 Model Specification and Variable Description

The seminal theoretical models, which are the basis for most of modern tax evasion models, were first derived by Allingham and Sadmo (1972), Srinivasan (1993) and another version by Yitzhaki (1974). These models study the behaviour of the taxpayer within the Von Neumann-Morgenstern axioms for behaviour under uncertainty. They are based on Baker's (1969) economic approach to crime. Following from Yithaki's model and the other works such as Clotfelter (1983) and Tanzi (1993) the empirical model to be estimated is presented as:

$$\ln TE_t = \alpha_0 + \alpha_1 \ln Ir_t + \alpha_2 \ln rPCY_t + \alpha_3 \ln ATR_t + \alpha_4 \ln AGE_t + \alpha_5 \ln GEND_t + \alpha_6 INF_t + \mu_t \quad (1)$$

The dependent variable *TE* represents the level of tax evasion for each period of the study. *Ir* is interest on bank deposits. The coefficient of the *Ir* variable captures the effect of a change in deposit interest rate on the amount of currency held for transactions by individuals. We therefore expect a negative relationship between *Ir* and *TE*. The

variable *rPCY* is the real per capita income. It is used as a proxy for the level of economic development. Per capita income is expected to be negatively related to the level of tax evasion. The coefficient of *ATR* illustrates the effect of changes in the average tax rate on the level of tax evasion. The average tax rate is computed as a share of total tax revenue in GDP for each period. It is expected to exhibit a positive relationship with the dependent variable.

AGE denotes the age of taxpayers and measured as the proportion of the population between 15 and 64 years[5]. This age interval represents younger taxpayers and we anticipate a positive relation between *AGE* and *TE.* The gender of a taxpayer is represented by the variable *GEND* where *GEND* is measured as the proportion of the population that is female. We expect a negative association between *GEND* and the level of tax evasion. *INF* represents the rate of inflation for the period of the study. *INF* is measured as the change in consumer price index. The coefficient of *INF* demonstrates the relationship between inflation and tax evasion which is expected to be positive. Ln is the natural logarithm of the respective variables. The dependent and independent variables are logarithmized to ease the interpretation of the coefficients as elasticities.

3.2 Technique of Analysis

The study employed time series data for the analysis. One problem often associated with time series data is non-stationarity. The use of non-stationary variables is likely to give misleading results. This study therefore begins its estimation process by first testing for unit roots. The Phillip- Peron (PP) test proposed by Phillips and Peron (1988) is employed for the unit root test. The PP test has an advantage over the Augmented Dickey Fuller test as it gives robust estimates when the series are serially correlated and also suffer from time-dependent heteroscedasticity. The Granger causality test based on the Granger (1969) procedure was also employed to detect causal relationships among the variables.

The bounds testing approach developed by Pesaran, Shin and Smith (2001) is used to test for the presence of a long-run relationship among the variables in this study. The bounds testing approach employs Autoregressive Distributed Lag (ARDL)[6] models. The use of this approach is based on several considerations. First, ARDL models generate consistent estimates of long-run coefficients that are asymptotically normal, regardless of whether the variables are purely I(0), purely I(1) or mutually cointegrated (Pesaran et al., 2001). In general, the technique provides unbiased estimates of the long-run model and valid *t*-statistics even in situations when the variables are endogenous. Moreover, ARDL models are suitable for small sample sizes, unlike the Johansen cointegration technique which in the same situation would result in considerable loss of degrees of freedom.

[5] In the empirical literature individuals age 65 and above represent older taxpayers. See Richardson (2006)

[6] See Nikopour (2003); Arby et al. (2010); Dell' Anno and Halicioglu (2010); Adriana AnaMaria, and Ion (2010) as other studies that used ARDL to estimate the shadow economy

To carry out the bounds test procedure, equation (1) is modeled as a conditional ARDL-error correction model stated below:

$$\Delta \ln TE_t = a_0 + \sum_{i=1}^{p} b_i \Delta \ln TE_{t-i} + \sum_{i=0}^{p} c_i \Delta \ln Ir_{t-i} + \sum_{i=0}^{p} d_i \Delta \ln rPCY_{t-i} + \sum_{i=0}^{p} e_i \Delta \ln ATR_{t-i} +$$

$$+ \sum_{i=0}^{p} f_i \Delta \ln AGE_{t-i} + \sum_{i=0}^{p} g_i \Delta \ln GEND_{t-i} + \sum_{i=0}^{p} h_i \Delta INF_{t-i} + U_t +$$

$$\phi_1 \ln TE_{t-1} + \phi_2 \ln Ir_{t-1} + \phi_3 \ln rPCY_{t-1} + \phi_4 \ln ATR_{t-1} + \phi_5 \ln AGE_{t-1} + \phi_6 \ln GEND_{t-1} +$$
$$+ \phi_7 INF_{t-1} + \varepsilon_t \qquad (2)$$

Where, Δ denotes the first difference operator, α_0 is the drift parameter and ε_t is the white noise error term. To determine the existence of cointegration, we first estimate the first differenced components of the above equation using ordinary least squares (OLS). The Schwartz Bayesian Criterion (SBC) is employed to select the optimum number of lags. We then ascertain the long-run relationship by restricting the coefficients of the lagged level variables to zero. The null hypothesis of no cointegration is tested against the alternative hypothesis of cointegration among the variables.

That is;

$$H_0 : \varnothing_1 = \varnothing_2 = \varnothing_3 = \varnothing_4 = \varnothing_5 = \varnothing_6 = \varnothing_7 = 0$$

$$H_1 : \varnothing_1 \neq \varnothing_2 \neq \varnothing_3 \neq \varnothing_4 \neq \varnothing_5 \neq \varnothing_6 \neq \varnothing_7 \neq 0$$

The null hypothesis is tested against the alternative by means of an F-test with an asymptotic non-standard distribution. Considering the ARDL approach, two asymptotic critical value bounds provide a test for cointegration when the independent variables are $I(d)$ with $0 < d < 1$ (Pesaran and Smith, 1995). The lower bound on the one hand, assumes that all the regressors are $I(0)$ and the upper bound on the other hand, assumes that they are $I(1)$. If the F-statistic computed lies above the critical upper bound value, we reject the null hypothesis regardless of the cointegration rank of the variables, indicating cointegration among the variables. However, if the computed F-statistic lies below the lower critical bound value, we fail to reject the null hypothesis of no cointegration relationship among the variables, implying the absence of long-run relationship. No conclusive decision is made when the *F*- statistic falls within the critical bound values. The critical values developed by Pesaran et al. (2001) are based on simulated large sample size. Therefore, this study uses the critical values developed by Narayan (2004), since it is more appropriate for small samples.

Once we establish that the variables are cointegrated, we proceed to estimate the long-run ARDL model in order to obtain the long-run coefficients and their asymptotic standard errors. The estimated model is as follows:

$$\ln TE_t = \alpha_0 + \sum_{i=1}^{n_1} \beta_i \ln TE_{t-i} + \sum_{i=0}^{n_2} \gamma_i \ln Ir_{t-i} + \sum_{i=0}^{n_3} \sigma_i \ln rPCY_{t-i} + \sum_{i=0}^{n_4} \varepsilon_i \ln ATR_{t-i} +$$

$$\sum_{i=0}^{n_5} \phi_i \ln AGE_{t-i} + \sum_{i=0}^{n_6} \lambda_i \ln GEND_{t-i} + \sum_{i=0}^{n_7} \theta_i INF_{t-i} + \mu_t \quad (3)$$

This is followed by the estimation of the short-run elasticities of the variables with the error correction representation of the ARDL model. By employing the error correction of the ARDL, we determine the speed of adjustment to equilibrium. The existence of long-run relationship among the variables necessitates the estimation of the unrestricted ARDL-error correction represented as:

$$\Delta \ln TE_t = a_0 + \sum_{i=1}^{n_1-1} b_i \Delta \ln TE_{t-i} + \sum_{i=0}^{n_2-1} c_i \Delta \ln Ir_{t-i} + \sum_{i=0}^{n_3-1} d_i \Delta \ln rPCY_{t-i} + \sum_{i=0}^{n_4-1} e_i \Delta \ln ATR_{t-i} +$$

$$\sum_{i=0}^{n_5-1} f_i \Delta \ln AGE_{t-i} + \sum_{i=0}^{n_6-1} g_i \Delta \ln GEND_{t-i} + \sum_{i=0}^{n_7-1} h_i \Delta INF_{t-i} + \lambda ECM + \mu_t \quad (4)$$

ECM is the error correction term and its coefficient (λ) is the speed of adjustment to the long-run following a shock to the system. It is expected to be negative and statistically significant so as to confirm the existence of cointegration among the variables in the model.

The reliability of the goodness of fit of the model is also determined by conducting the diagnostic and stability tests of the model. The diagnostic test takes care of heteroscedasticity, autocorrelation, normality and the functional form that are linked to the model. According to Pesaran and Pesaran (1997) the CUSUM and CUSUMSQ are employed in performing parameter stability tests.

3.3 Data Type and Sources

Annual time series data covering the period 1970-2010 is employed for the study. The dataset is obtained from a wide range of sources. Information on the currency in circulation is obtained from the Bank of Ghana and International Monetary Fund's International Financial Statistics (IFS) year books (1996, 2004 and 2010). Also, data on AGE, GEND, RPCY and INF are from the World Bank Development Indicators. Likewise, tax revenue values are obtained from the Ghana Revenue Authority. Given that data on tax evasion is generally unavailable, the study generated estimates for tax evasion for the period 1970 to 2010 by first estimating the size of the shadow economy based on Tanzi's (1983) monetary model (See Appendix for the illustration of how the model is used to estimate the tax evasion).

4. Discussion of Results

We proceed with our estimation by testing for the presence of unit roots in all the variables used in our ARDL model. Even though ARDL cointegration technique does not require pre-testing of the variables for unit root, this test is conducted to ensure that the variables are not integrated of order greater than one. Employing the Phillip-Perron test for unit root, we initially examined all the variables to verify whether they were stationary at levels. For the variables that were not, we first differenced them to assess whether they would be stationary or not. In both estimations, we tested the null hypothesis (presence of unit root) against the alternative hypothesis (see Appendix II for discussion on unit root test results).

Prior to testing the presence of a long-run relationship among the variables, it is important that we determine the lag length of the ARDL model. Pesaran and Shin (1999) suggest a maximum lag length of 2 for annual data in the bounds testing approach to cointegration, so given that the ARDL model uses annual data, we include a lag length of 2. After establishing the lag length, we compare the *F*-statistic computed within the unrestricted error correction framework of the bounds test with the lower and upper critical values developed by Narayan (2004). The F-statistic tests the joint null hypothesis that the coefficients of the lagged levels are zero, that is, there is no long-run relationship among the variables. The result of the bounds test for the presence of a long-run relationship is presented in Table 1.

Table 1: Bounds Test for the presence of Cointegration

Critical Value Bounds of the F-statistics (Unrestricted Intercept and no Trend)					
90% Level		95% Level		99% Level	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
2.442	3.400	2.907	3.982	3.983	5.448
Calculated F-statistics: 4.537**					

Source: Narayan (2004), ** indicates 5 per cent significance level

From Table 1, the calculated F-statistic of 4.537 lies above the upper critical bound of the 5 per cent significance level of 3.982. This implies that the null hypothesis of no cointegration among the variables of our ARDL model is rejected at the 5 per cent significance level. This result suggests that there exists a long-run relationship among tax evasion and the explanatory variables of the model, and these explanatory variables can be treated as "long-run forcing" variables for the explanation of tax evasion in Ghana. Establishing this relationship, we further estimate our ARDL model to determine the long-run relationship and short-run dynamics.

We estimate the impact of the explanatory variables on tax evasion in the long-run. Table 2 presents the results of the long-run estimate based on the Schwartz Bayesian

Criterion (SBC). The diagnostic test section of Table 2 illustrates that the selected ARDL (0, 0, 1, 0, 1, 0, 1) passes the standard diagnostic test of; serial correlation, functional form, normality and heteroscedasticity.

Table 2 also shows that all the explanatory variables with the exception of deposit interest rate (*Ir*) are significant. Although insignificant, *Ir* bears the expected negative signage. The insignificance of *IR* runs contrary to the results of studies such as Tanzi (1983) and Klovland (1984). Both studies found deposit rate of interest to be negative and significantly related to tax evasion in United States, Norway and Sweden respectively. Our result suggests that, any change in the deposit interest rate of financial assets does not affect the opportunity cost of holding cash. Probably, most Ghanaians find the gains from bank deposits to be relatively low compared to the gains realised when the same amount is engaged in transactions outside the banking sector.

Table 2: Long-run Estimates based on SBC-ARDL (0, 0, 1, 0, 1, 0, 1)

Dependent variable is LTE

Variable	Coefficient	Standard error	T-Ratio [Prob]
LnIr	-0.0083106	0.0065587	-1.2671 [0.216]
LnrPCY	-2.1981***	0.72691	-3.0239 [0.005]
LnATR	0.024170***	0.0027577	8.7646 [0.000]
LnAGE	0.0038589***	0.0010185	3.7887 [0.001]
LnGEND	-0.22619***	0.030465	-7.4246 [0.000]
INF	0.0078579***	0.0016802	4.6767 [0.000]
C	0.13525	0.024188	5.5918 [0.000]

Diagnostic test

Test Statistics	**LM Version**	**F Version**
Serial Correlation	CHSQ (1) = 0.64525 [0.422]	F (1, 26) = 0.44911 [0.509]
Functional Form	CHSQ (1) = 0.29032 [0.590]	F (1, 26) = 0.20017 [0.658]
Normality	CHSQ (2) = 0.73096 [0.694]	Not applicable
Heteroscedasticity	CHSQ (1) = 0.026570 [0.871]	F (1, 36) = 0.02518 [0.875]

Source: Authors' calculation using Microfit 4.1. ***: Significant at 1%; **: Significant at 5%

The rest of the discussion focuses on the significant predictors of tax evasion (Table 2). As expected, per capita income is (*rPCY*) inversely related to tax evasion. This finding is consistent with that of Tanzi (1983) for the United States and Sookram and Watson (2005) for Trinidad and Tobago among others. The estimated coefficient for *rPCY* suggests that a one per cent increase in the real per capita income of economic agents will cause tax evasion to reduce by 2.20 per cent, all other factors remaining the same. One possible explanation for the inverse relationship is that economic development involves the development of various institutions (such as the domestic revenue mobilisation institutions) and sectors of the economy. Therefore, improving domestic revenue mobilisation institutions leads to higher capacity to collect taxes, resulting in a fall in the level of tax evasion. Also, an improvement in the revenue mobilisation institutions in Ghana will increase their ability to detect potential tax evaders and reduce future tax evasion. Another explanation is that at low incomes, economic units have a high tendency of engaging in several jobs but report incomes on only one job causing a rise in the level of tax evaded. On the other hand, high per capita income may reduce the tendency of economic agents holding other jobs and underreporting their incomes.

The average tax rate (*ATR*) exhibits a positive relationship with tax evasion. Further, it shows that a one per cent rise in the average tax rate causes tax evasion to rise by 0.02 per cent, all other things being the same. This result could be due to the fact that, at constant income, increases in tax rates reduce the disposable income of taxpayers, motivating them to secure other jobs in the shadow economy in order not to report earned income and evade tax liabilities. Clotfelter (1983), Trehub and Krasnikova (2005), Schneider et al. (2008) had similar results in their studies where the average tax rate was found to exhibit a positive and significant impact on tax evasion.

The literature on the direction of the impact of inflation on tax evasion is inconclusive. Crane and Nourzad (1986) observe a positive and statistically significant relationship between inflation and tax evasion in the long-run. On the other hand, Klovland (1984) finds that in Sweden there exists a negative and statistically significant relation between inflation and tax evasion at equilibrium. In addition, Sookram and Watson (2005) find a negative and statistically significant link between inflation and tax evasion in Trindad and Tobago.

With regard to inflation (*INF*) and tax evasion, our results suggest a positive relationship. Further, the estimated coefficient of *INF* shows that a one per cent increase in inflation rate will increase tax evasion by 0.008 per cent, holding other factors constant. The possible reason accounting for this result is that the wage structure of the formal sector in the economy is not inflation indexed. Therefore, higher inflation affects the after-tax income of taxpayers and reduces their disposable income. In order to maintain a consistent consumption pattern, most taxpayers participate in activities of the hidden economy to earn extra incomes which are unrealised by the tax authorities.

Concerning the demographic variables, age (*AGE*) and gender (*GEND*), we observed that at equilibrium, the age variable influences tax evasion positively. Also, the estimated coefficient of *AGE* suggests that as the proportion of the population between 15-64 years of age increases by one per cent, the level of tax evasion also increases by 0.004 per cent, all

other determinants treated as constant. The result suggests that younger taxpayers in Ghana are more risk-seeking and less sensitive to sanctions. Though Richardson (2006) found the impact of age to be insignificant on tax evasion, both Clotfelter (1983) and Feinstein (1991) observed that older taxpayers were more tax compliant.

Finally, we found a negative relationship between gender and tax evasion. The result shows that, a one per cent increase in the proportion of the population which is female results in 0.23 per cent decrease in tax evasion in Ghana in the long run. This negative relationship suggests that women in Ghana are more likely to be tax compliant. In contrast, Trehub and Kransikova (2005) found that women in Russia are more likely to evade tax liabilities.

The evidence that the variables in our model are cointegrated provides support for the use of an error correction model (ECM) so as to examine the short-run dynamics. The results of the short-run dynamics associated with the ARDL (0, 0, 1, 0, 1, 0, 1) are illustrated in Table 3. The error correction term has a coefficient of -0.4505 which is statistically significant at the 1 per cent level. This helps to reinforce the findings of a long run relationship among the variables in the model. The magnitude of the coefficient of the error correction term signifies that 45 per cent of deviations from the equilibrium level of tax evasion is corrected each year. Furthermore, an R-squared of 0.79 suggests that the explanatory variables included in our model explain 79 per cent of the level of tax evasion. The remaining 21 per cent is accounted for by variables excluded in our tax evasion model and which are accounted for by the error term.

Table 3 shows that all the explanatory variables with the exception of deposit interest rate are statistically significant in the short run. Interestingly, the signs associated with each of the explanatory variables are consistent with the long run results discussed earlier. However, the magnitudes of the estimated coefficients differ from that of the long-run estimates.

Table 3: Short-run Dynamic Results ARDL (0, 0, 1, 0, 1, 0, 1)

Dependent variable is LTE

Variable	Coefficient	Standard Error	T-Ratio [Prob]
dLnIr	-0.0083106	0.0065587	-1.2671 [0.215]
dLnrPCY	-0.29821***	0.079104	-3.7699 [0.001]
dLnATR	0.024170***	0.0027577	8.7646 [0.000]
dLnAGE	0.12366***	0.033056	3.7409 [0.001]
dLnGEND	-0.0030919**	0.0011715	-2.6393 [0.015]
dINF	0.0037150***	0.0011066	3.3572 [0.002]
C	0.40014	0.2084	1.9169 [0.068]
ECM(-1)	-0.45048	0.9582	-4.7013 [0.000]

ecm = LTE + 0.0083106IR + 2.1981LRPCY - 0.024170ATR - 0.0038589LAGE +.22619LGEND - 0.0078579INF - 0.13525C

R-Squared	.79490	R-Bar-Squared	0.71893
S.E. of Regression	0.15256	F-stat. F(8, 29)	13.0800 [0.000]
Mean of Dependent Variable	-0.016029	S.D. of Dependent Variable	0.28776
Residual Sum of Squares	0.62840	Equation Log-likelihood	24.1213
Akaike Info. Creterion	13.0213	Schwarz Bayesian Criterion	4.0146
DW-statistics	2.2260		

Source: Results obtained using Microfit Version 4.1

The real per capita income variable (*rPCY*) exhibits a negative and statistically significant effect on tax evasion. The estimated coefficient associated with *rPCY* shows that in the short-run, a one per cent rise in the real per capita income reduces the level of tax evasion in Ghana by 0.30 per cent (Table 3). Moreover, short-run changes in both average tax rate and the rate of inflation are statistically significant and have positive impacts on the level of tax evasion. As the average tax rate and the rate of inflation increase by one per cent, tax evasion increases by 0.02 and 0.004 percent respectively.

Table 3 further shows that age (*AGE*) has a positive and statistically significant influence on tax evasion at the 1 per cent significance level in the short run. The results above demonstrate that a 1 per cent rise in the proportion of the population between 15-64 years of age results in 0.12 per cent increase in tax evasion. Gender (*GEND*) also exhibits a negative and statistically significant relation with tax evasion, suggesting that a percentage increase (decrease) in proportion of the population that is female will decrease (increase) the level of tax evasion in the short-run.

4.1 Granger Causality Test Results

The causal relationship between tax evasion (*LTE*), the average tax rate (*ATR*) and rate of inflation (*INF*) are reported in Table 4. The result shows that average tax rate Granger- causes tax evasion. Moreover, the result shows a unidirectional relationship between average tax rate and tax evasion for the period under consideration. The result also suggests that not only do past values of tax evasion aid in predicting its future values but tax rate variable is also important in predicting future values of tax evasion. In addition, we observed a weak unidirectional relationship between the inflation rate and tax evasion (significant at 10%). The result implies that inflation rate is a vital variable which aids in predicting future levels of tax evasion. The results confirm our earlier claim that both the tax variable and the inflation rate influence tax evasion in Ghana.

Table 4: Pairwise Granger Causality Test Results

Null hypothesis	F-Statistics	Probability	Comment
LnATR does not Granger Cause LnTE	3.74992	0.03442	Null rejected
LnTE does not Granger Cause LnATR	1.20853	0.31114	Null not rejected
INF does not Granger Cause LnTE	2.52358	0.09684	Null rejected
LnTE does not Granger Cause INF	0.62425	0.54169	Null not rejected

Source: Author's computation using EViews 5.

5. Conclusion and Recommendations

This paper sought to identify the factors that contribute to the extent of tax evasion in Ghana, using time series data covering the period 1970-2010. Employing the currency demand approach, we obtained the estimates of the shadow economy and the level of tax evasion for the entire period. We then adopted the bounds testing technique to cointegration to ascertain the determinants of tax evasion. First, the variables in the study were tested for stationarity using the Philips-Perron test.

The econometric evidence suggests that the variables included in our ARDL model are bounded together. The results based on the long run estimates show that average tax rate, age and inflation rate have positive and statistically significant impact on tax evasion. Conversely, real per capita income and gender do exert negative and statistically significant effect on tax evasion. Besides, deposit interest rate though carried the correct signage, had an insignificant effect on tax evasion in the long run. The short run estimates were consistent with the long run estimates. However, there were differences in the magnitudes and levels of significance of the estimates. The error correction term was negative, statistically significant and shows that 45 per cent of the deviation from equilibrium tax evasion is corrected each year. Our empirical finding based on the Granger causality test suggests that the tax rate and inflation rate aid in predicting future levels of tax evasion in Ghana.

The study found that an increase in the tax variable raises the level of tax evasion in Ghana for the period under review. On this note, we recommend that the tax authorities should widen the tax base to include as much items and individuals as possible and slightly reduce the tax rates in a manner that the net effect on tax revenue will be an increase. This will serve to reduce the level of tax evasion.

Additionally, we observed a positive relationship between the rate of inflation and tax evasion such that an increase in the inflation rate will lead to a rise in tax evasion in Ghana. Hence, we propose that the current effort by the Bank of Ghana to maintain single digit inflation should not be relented on in addition to identifying the optimal level of inflation in the economy.

Given that the proportion of younger taxpayers in the population increases tax evasion, we propose that tax authorities should pay keen attention to younger taxpayers.

This will include ascertaining the average income level of a representative young taxpayer. In line with the results obtained earlier that an increase in the female population leads to a reduction of tax evasion in Ghana, we similarly recommend that the tax authorities should focus less on female tax payers but channel a greater proportion of their resource in monitoring male tax payers.

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Appendices

Appendix I: Estimating Tax Evasion

The monetary approach[7] to measuring the size of the shadow economy and tax evasion[8] has become the most popular approach. This approach, also known as the currency demand approach was initiated by Cagan (1958) and further developed by Tanzi (1980). The approach assumes that shadow transactions are conducted in cash payments to leave no observable traces for the authorities. In order to hide the source of income from tax authorities, economic agents in the shadow economy are more likely to use cash. In this sense, a rise in the currency ratio, ceteris paribus, could represent an increase in the shadow economy. Tanzi (1983) assumes that the currency demand approach is based on a correlation between the demand for currency and the tax pressures such that, the shadow economy is nonexistent when taxes are zero. He further states that the difference between the estimated currency (with taxes) and the estimated currency (under the assumption of zero taxes) produces an estimation of currency in the shadow economy.

Empirical studies such as Tanzi (1983), Klovland (1984), Faal (2003) and Bekoe (2010) have identified certain key factors that influence the level of currency holding by the public at any period. Employing a number of these determinants of currency ratio, we develop and estimate a currency demand equation in order to determine the size of the shadow economy and tax evasion. Employing an Ordinary Least Squares (OLS) technique, we estimate a currency demand equation of the form:

$$\ln\left(C/M2\right)_t = \beta_0 + \beta_1 \ln ATR_t + \beta_2 \ln Ir_t + \beta_3 \ln rPCY_t + \beta_4 \ln(EDU_t) + \beta_5 \ln(URPOP_t) + \varepsilon_t \quad \text{(A.1)}$$

Where:

$C/M2$ = Currency- M2 ratio
ATR = Tax variable
Ir = Interest rate
$rPCY$ = real per capita income
EDU_t = Education level (measured as educational attainment in terms of the average years of schooling for the total population over the age of 15 years);

[7] In spite of its popularity the method has been strongly criticized from different angles (see Cardi and Passerini, 2001; Thomas, 1999, and Breusch, 2005 and 2005b) but these have been amply addressed by other authors (See Schneider and Enste, 2000 and Schneider, 2002). A recent adjustment to the monetary method has been argued by Ahumada et al. (2007, 2008). The authors propose that the monetary method only produces consistent estimates if the income elasticity of demand for currency is unitary and suggested different ways for estimation if the elasticity were otherwise. They re-estimated the shadow economy for Argentina, Bolivia, Australia, Norway and Tanzania and had different results from previous studies.

[8] Results on tax evasion estimates not presented to avoid inundation of pages in this paper

$URPOP_t$ = Urbanization (measured as percentage of the population living in cities)
ε_t = Error term
Ln = Natural Logarithm

By using the results from the estimated currency-M2 model, we then proceed to find estimates for the size of underground economy and tax evasion through the following steps as applied in studies such as Tanzi (1980, 1983), Schneider (2007) and Schneider and Enste (2000, 2002). First we find the amount of illegal money in the economy, followed by legal money, then, velocity of money, the underground economy and finally tax evasion as follows:

$$\text{Illegal Money (IM)} = \left(\left(\frac{C}{M2}\right)_t - \left(\frac{C}{M2}\right)_{wt}\right) * M2 \tag{A.2}$$

where:

$\left(\frac{C}{M2}\right)_t$ = the currency-M2 equation with the tax rate;

$\left(\frac{C}{M2}\right)_{wt}$ = the currency-M2 equation without the tax rate;

$M2$ = Broad definition of money (M1 plus time deposits)

$$\text{Legal Money (LM)} = M1 - IM \tag{A.3}$$

where:

M1 = Narrow Definition of money (currency plus demand deposits)
IM = Illegal money obtained from equation (A.2)

$$\text{Velocity (V)} = \frac{GNP}{LM} \tag{A.4}$$

where:

GNP = Gross National Product
LM = Legal Money obtained from equation (A.3)

$$\text{Underground Economy } (UE) = IM * V \tag{A.5}$$

where:

IM = Illegal Money
V = Velocity of Money derived from equation A.(4)

$$\text{Tax Evasion } (TE) = UE * \left(\frac{\text{Total Taxes}}{\text{GNP}}\right) \tag{A.6}$$

where:

UE = Underground Economy derived from equation (A.5)
GNP = Gross National Product

Appendix II: Discussion of Unit Root Results

The Mackinnon (1996) critical values were used in making a conclusion as to rejecting or failing to reject the null hypothesis. Whenever the absolute value of the calculated statistics is greater (lesser) than the critical value, we reject (fail to reject) the null hypothesis and conclude that the variable is stationary (non-stationary). Tables A1 and A2 present the results of the unit root test at level and first difference respectively.

Table A1: Unit Root Test Results at Levels

Variable	PP Statistics	PP critical	P-Value
LnTE	-2.161829	-3.194611	0.4970
LnIr	-1.854855	-3.194611	0.6589
LnrPCY	-0.593834	-3.194611	0.9740
LnATR	-2.146621	-3.194611	0.5051
LnAGE	-5.473174	-4.205004	0.0003
LnGEND	-4.017102	-3.526609	0.0160
INF	-4.730021	-4.205004	0.0025

Source: Author's computation using EViews 5.

From the Table A1, we realised that *LnAGE*, *LnGEND* and *INF* have the absolute values of their PP statistics being greater than their critical values and also with significant probability values. We therefore reject the null hypothesis and conclude that these three variables are stationary at levels or integrated of order zero.

Table A2 on the other hand, presents results of variables that were not stationary at levels and had to be differenced. After differencing, the following variables; Ln*TE*, Ln*Ir*, Ln*rPCY* and Ln*ATR* exhibit PP statistics greater than their critical values in absolute terms and also show probability values which are significant at 1 per cent level. We reject the null hypothesis and conclude that Ln*TE*, Ln*Ir*, *LnrPCY* and Ln*ATR* are stationary at first difference or integrated of order one.

Table A2: Unit Root Test Results at First Difference

Variable	PP Statistics	PP Critical	P-Value
LnTE	-7.105130	-4.211868	0.0000
LnIR	-5.704630	-4.211868	0.0002
LnRPCY	-6.809942	-4.211868	0.0000
LnATR	-5.895970	-4.211868	0.0001

Source: Author's computation using EViews 5.

Combining the results in Tables A1 and A2, the order of integration of the variables used in the study are shown in the Table A3:

Table A3: Order of Integration of Variables

Variable	Order of Integration
LTE	I(1)
IR	I (1)
LRPCY	I(1)
ATR	I(1)
LAGE	I(0)
LGEND	I(0)
INF	I(0)

Source: Author's compilation

Appendix III: Diagnostic and Stability Test Results

It is evident from Table 2 that our ARDL (0, 0, 1, 0, 1, 0, 1) model passes the standard diagnostic test[9]. However, it is important to investigate whether the above long and short run relationships established in the study are stable for the entire period of the study. For this purpose, we test for parameter stability which is based on the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) test proposed by Brown, Durbin and Evans (1975). On the one hand, the CUSUM test employs the cumulative sum of recursive residuals based on the first "n" observations, updated recursively and plotted against break point. The CUSUMSQ on the other hand, uses the squared recursive residuals and follows the above procedure. In instances where both the CUSUM and CUSUMSQ stay within the 5 percent critical bound, the null hypothesis that all coefficients are stable cannot be rejected. The result clearly indicate that both CUSUM and CUSUMSQ plots lie within the 5 percent critical bound therefore, providing a confirmation that over the entire period of the study, the parameters of the model do not suffer from any structural instability[10].

[9] That is the test for serial correlation, functional form, normality and heteroscedasticity.

[10] Result of the stability test is not presented to avoid inundation of pages in this paper

Gender Differences in Life Satisfaction and Social Participation

Stephan Humpert[*,**]

Abstract

The paper deals with the effects of social participation activities on life satisfaction. Using the German General Social Survey (ALLBUS) for 2010, marginal effects of binary probit estimations on life satisfaction are presented. Strong gender differences are observable. While sport, welfare or parental activities affect only female life satisfaction, males are more affected by classical hobbies. As an interesting result that political activities, such as a political party or a union membership, have no or even negative effects. The general results may be interpreted in that way, that activities or memberships with influence in local fields with own responsibility and personal interest in a short of time, may be more satisfying than activities with more idealistic tasks and long run results, such as protecting nature or human rights.

Keywords: Subjective Well-Being, Social Participation, German General Social Survey (ALLBUS)

JEL Classification: I31, D60, Z13

1. Introduction

In Germany millions of individuals are members of clubs and associations. Literately Germany is a club nation. About 580.000 different associations exist in 2011 (NPO, 2011). For example the federal statistics office reveals 91.000 sports clubs with 24 million members nationwide. E.g. 7 million of these sportsmen are members of a local football club (Statistisches Bundesamt, 2011). But why are there so many members? From a social scientist's point of view, a membership is like an investment in social capital[1]. Any investment should bring some utility. Hence individuals may get non-monetary benefit such as of joy and satisfaction from being a part of a strong community with similar thoughts and beliefs. However different motivations such as career or business related networking may

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[**] This work is the the private opinion of the author.

[1] See Gannon and Roberts (2012) for an economical discussion of the sociological concept of social capital.

improve future monetary benefits, as well. Psychologists demonstrate that some activities can bring a long term increase in satisfaction. These are the so-called intentional activities, where individuals have to invest some time and personal effort (Lyubomirsky et al., 2005).

Table 1 shows gender and age specific participation rates for voluntary work[2] in Germany taken from the new ALLBUS 2012 data: 3.9 percent of males and 2.4 of females volunteer, every day, while 18.2 percent of the males and 14.8 percent of the females volunteer once a week. However 52 percent of the males and 57 percent of the females never volunteer. The most work is done by the youngest (18 to 29 years) and the middle aged individuals (30 to 59 years). The elderly (60 and older) report the lowest volunteering rates.

Table 1: Age and Gender Differences - Volunteering in Leisure Time

	Every Day	Once a Week	Once a Month	Less often	Never	Total
Gender						
Male	3.90%	18.15%	10.12%	15.94%	51.89%	100%
Female	2.36%	14.80%	10.48%	15.32%	57.03%	100%
Total	3.13%	16.47%	10.30%	15.63%	54.47%	100%
Age						
18-29 Years	2.17%	19.23%	10.87%	22.24%	45.48%	100%
30-44 Years	3.77%	12.65%	12.11%	16.69%	54.78	100%
45-59 Years	3.38%	18.42%	10.03%	15.81%	52.36%	100%
60-74 Years	3.05%	17.01%	10.66%	12.06%	57.23%	100%
75-89 Years	2.77%	12.11%	4.50%	8.30%	72.32%	100%
Total	3.13%	16.47%	10.30%	15.63%	54.47%	100%

Source: ALLBUS 2012 (GESIS, 2013)
Note: Own calculation

In this paper I try to analyze if and how a membership of a social activity organization affects the personal life satisfaction. Some of them are political or welfare activities, others are more leisure time orientated. Others have direct effects on personal living conditions, such as parental organization, while others have long run idealistic topics, such as peace or nature protection. Additionally some of them have topics for all ages, such as culture, while others, such as senior associations are specialized to some age groups. But they have all in common that a membership is voluntary, costs time and money to participate and may involve voluntary work, as well. These are the different organizations an individual may

[2] Yamamura (2013) shows that exogenous shocks, such as natural catastrophes, can increase rates and duration of volunteering.

attend: a cultural society, a sports club, a hobby society, a charity organization, a human rights organization, a nature protection association, a health club, a parents association, a senior association, a citizen initiative, an other association, a union or a political party. It is obvious that these organized groups differ in their goals, but in general there are comparable.

However it is a limitation of the analysis that I do not have information about the real intensity of participation and the dimension of membership fees, so I understand pure membership as a proxy for any participation.

I use the German General Social Survey (ALLBUS) for 2010 and present marginal effects of binary probit estimations on life satisfaction. There are strong gender differences in the results. While sport, welfare or parental activities affect only female life satisfaction, males are more affected by classical hobbies. It is an interesting finding that political activities, such as a political party or a union membership have no or even negative effects. The results may be interpreted in that way, that activities or memberships with influence in local fields with own responsibility and personal interest in a short of time, may be more satisfying than activities with more idealistic tasks and long run results, such as protecting nature or human rights.

This paper is organized as follows: after introduction, the second section shows findings of the relevant literature. In the third section, I describe the data set and the used estimation model. In the forth section, I discuss the results. In the fifth section, I present some a concluding remarks. A section on limitations of the study is at the end.

2. Literature Review

Sociologists know the importance of participation for decades. Phillips (1967) shows for the U.S. that social participation and voluntary work lead to higher life satisfaction.

Psychological studies show three different kinds of activities that improve satisfaction differently.

At first, physical activities, such as sports have a great influence on health and life satisfaction. Downward and Rasciute (2011) use 2005 UK data to show positive frequency and duration effects of sports on life satisfaction. They find clear evidence that activities with individual interaction, such as team sports, lead to higher satisfaction. With the same data set the authors show that even simple activities, such as walking or cycling can affect health and life satisfaction positive (Rasciute and Downward, 2010).

Second, any kind of social interactions improve satisfaction, as well. E.g. Heady et al. (2010) present results from the German SOEP data that clearly show for both sexes, that social interaction, such as meeting and helping friends, relatives or neighbors, increase satisfaction. With the same data set Becchetti et al. (2008) show that attending social meetings and cultural events, are as positive as participation in sports or voluntary work. Barker and Martin (2011) discuss that politics and life satisfaction have an interaction. Sharing equal ideas and beliefs, political organizations can increase satisfaction of their

members and participants[3]. Howard and Gilbert (2008) use European and US social survey data to analyze the impact of passive or active involvement on life satisfaction. In Western Europe effects of passive membership or donating both increase life satisfaction by 50 percent, while active membership and participation increase satisfaction by 51 percent, both relative to non-membership. These effects are smaller for the US.

Rodriguez-Pose and von Berlepsch (2013) use Europeans social surveys data and present evidence, that political activities, such as working for a party or campaigning have mixed effects on satisfaction, while union membership affects satisfaction positive. Humpert and Krüger (2012) show with German SOEP data that job satisfaction is not negative affected by a union membership[4].

The third group are those of happiness increasing activities. Lyubomirsky et al. (2005) discuss an earlier study that showed, that helping others can improve life satisfaction substantially over the baseline level, when it is done frequently and in short intervals. Using UK data Kroll (2011) analyzes the effects of civic engagement and voluntary work on life satisfaction. Women and especially mothers participate more often than men in civic commitment. Here women with low or high levels of social capital benefit from participation in terms of satisfaction. Meier and Stutzer (2008) show with German SOEP data that pro social behavior, such as voluntary work, is more often done by intrinsic motivated individuals. This intrinsic volunteers report higher levels of life satisfaction, than volunteers with extrinsic goals in life.

Aknin et al. (2013) present results from four experimental studies worldwide that individuals receive psychological benefit from donating money to charity organizations. They report that pro social behavior increase life satisfaction. In an experimental design Aknin et al. (2012) show that individuals who remember past donation feel more satisfied, and will give money in the future. Lelkes (2010) uses 2006 EU-SILC, and 2004 and 2006 European social survey data to show that voluntary activities are common especially in the Scandinavian countries and the Netherlands. On one hand social activities such as acting with friends and relatives, or charity work increase life satisfaction significant. On the other hand the absence from any social participation can lower life satisfaction. Social isolation is especially a problem for the oldest ages.

3. Data and Method

I use the 2010 wave of the German General Social Survey (ALLBUS), a social-economic cross-section data set provided by the GESIS Group (GESIS, 2011). Although

[3] Scarrow (1994) discusses a set of seven more or less important points why individuals may join a political party. The most important one is, that only party member will be future party candidates. The other six points may be done by non-registered party followers as well. Frey and Stutzer (2000) show that even democracy in itself increases life satisfaction.

[4] In Germany political parties and unions have lost high numbers of members over time. See Van Bietzen et al. (2012) for a discussion of party members and Fitzenberger et al. (2011) for union members.

the 2012 wave has a direct question on volunteering, I use the 2010 wave because here I have information about several different kinds of participation. The data includes 2,827 individuals with about 1,000 variables. For my analysis I limit the data to 2,128 individuals. There are two samples, separated for males and females. So I observe 1,077 men and 1,051 women. The question concerning life satisfaction is a proxy for economic utility. It is asked like that:

"And now a general question. All things considered,
how satisfied are you with your life as a whole these days?"

For the dependent variable I collapse the scale from 0 to 10 into a binary scale. The dummy is zero (not satisfied) when satisfaction is reported from 0 to 7, and one (satisfied) if it is reported from 8 to 10. It is not an unusual procedure to recode the longer scale into a binary variable. This is used e.g. in papers by Fleming and Kler (2008) or Kassenboehmer and Haisken-DeNew (2009).

The descriptive statistics separated for males and females are presented in Table 2.

Table 2: Descriptive Statistics

	Male					Female				
Variable	Observation	Mean	Std. Dev.	Min	Max	Observation	Mean	Std. Dev.	Min	Max
Life Satisfaction	1,077	0.7168	0.4508	0	1	1,051	0.7288	0.4448	0	1
Age 30-44	1,077	0.2470	0.4315	0	1	1,051	0.2379	0.4260	0	1
Age 45-59	1,077	0.3027	0.4596	0	1	1,051	0.2797	0.4491	0	1
Age 60-74	1,077	0.2256	0.4182	0	1	1,051	0.2502	0.4334	0	1
Age 75-89	1,077	0.0761	0.2653	0	1	1,051	0.1018	0.3025	0	1
Born in Germany	1,077	0.8570	0.3502	0	1	1,051	0.8516	0.3557	0	1
House Owner	1,077	0.5738	0.4948	0	1	1,051	0.5138	0.5000	0	1
Fair Health	1,077	0.2748	0.4466	0	1	1,051	0.2769	0.4477	0	1
Bad Health	1,077	0.1504	0.3576	0	1	1,051	0.1770	0.3818	0	1
Secondary School	1,077	0.3389	0.4736	0	1	1,051	0.3606	0.4804	0	1
O-Level	1,077	0.3278	0.4696	0	1	1,051	0.3701	0.4831	0	1
Advanced Certificate	1,077	0.0715	0.2578	0	1	1,051	0.0428	0.2025	0	1
A-Level	1,077	0.2461	0.4309	0	1	1,051	0.2131	0.4097	0	1
Part Time Work	1,077	0.0251	0.1564	0	1	1,051	0.1836	0.3874	0	1
Marginal Work	1,077	0.0241	0.1536	0	1	1,051	0.0790	0.2698	0	1
No Work	1,077	0.3454	0.4757	0	1	1,051	0.4206	0.4939	0	1
Culture Society	1,077	0.1133	0.3171	0	1	1,051	0.1370	0.3440	0	1
Sports Club	1,077	0.3027	0.4596	0	1	1,051	0.2569	0.4371	0	1
Hobby Society	1,077	0.1383	0.3454	0	1	1,051	0.0714	0.2575	0	1
Charity Organization	1,077	0.0854	0.2796	0	1	1,051	0.1009	0.3013	0	1
Human Rights Organization	1,077	0.0093	0.0960	0	1	1,051	0.0162	0.1262	0	1
Nature Association	1,077	0.0594	0.2365	0	1	1,051	0.0733	0.2607	0	1
Health Club	1,077	0.0399	0.1959	0	1	1,051	0.0552	0.2285	0	1

Parents Association	1,077	0.0241	0.1536	0	1	1,051	0.0476	0.2130	0	1
Senior Association	1,077	0.0241	0.1536	0	1	1,051	0.0219	0.1464	0	1
Citizens Initiative	1,077	0.0158	0.1247	0	1	1,051	0.0114	0.1063	0	1
other Association	1,077	0.1049	0.3066	0	1	1,051	0.0561	0.2303	0	1
Union	1,077	0.1718	0.3774	0	1	1,051	0.0951	0.2936	0	1
Political Party	1,077	0.0511	0.2202	0	1	1,051	0.0266	0.1611	0	1
Separated	1,077	0.0241	0.1536	0	1	1,051	0.0200	0.1400	0	1
Widow	1,077	0.0362	0.1869	0	1	1,051	0.1361	0.3430	0	1
Divorced	1,077	0.0752	0.2639	0	1	1,051	0.1304	0.3369	0	1
Single	1,077	0.2656	0.4418	0	1	1,051	0.2160	0.4117	0	1
Kids out of Home	1,077	0.2433	0.4293	0	1	1,051	0.2521	0.4344	0	1
Kids at Home	1,077	0.4457	0.4973	0	1	1,051	0.4995	0.5002	0	1
Hamburg	1,077	0.0139	0.1172	0	1	1,051	0.0114	0.1063	0	1
Lower Saxony	1,077	0.0724	0.2593	0	1	1,051	0.0847	0.2785	0	1
Bremen	1,077	0.0037	0.0609	0	1	1,051	0.0095	0.0971	0	1
North Rhine Westphalia	1,077	0.1662	0.3724	0	1	1,051	0.1541	0.3613	0	1
Hesse	1,077	0.0650	0.2466	0	1	1,051	0.0676	0.2511	0	1
Rhineland-Palatinate/Saarland	1,077	0.0501	0.2183	0	1	1,051	0.0352	0.1844	0	1
Baden-Wurttemberg	1,077	0.0947	0.2929	0	1	1,051	0.0980	0.2975	0	1
Bavaria	1,077	0.1402	0.3474	0	1	1,051	0.1846	0.3881	0	1
Berlin	1,077	0.0288	0.1673	0	1	1,051	0.0352	0.1844	0	1
Brandenburg	1,077	0.0585	0.2348	0	1	1,051	0.0561	0.2303	0	1
Mecklenburg-Western Pomerania	1,077	0.0511	0.2202	0	1	1,051	0.0400	0.1960	0	1
Saxony	1,077	0.0845	0.2783	0	1	1,051	0.0676	0.2511	0	1
Saxony Anhalt	1,077	0.0734	0.2608	0	1	1,051	0.0685	0.2527	0	1
Thuringia	1,077	0.0631	0.2433	0	1	1,051	0.0561	0.2303	0	1
HH Income	1,077	2,582.12	1,543.96	90	10,000	1,051	2,263.90	1,515.89	150	17,000

Source: ALLBUS 2011 (GESIS, 2012)

Note: Own calculation

The main independent variable is a dummy variables which is one if the individual is member of one of the social groups. Otherwise the dummy variable is zero. The variables are the following: memberships of a cultural society, a sports club, a hobby society, a charity organization, a human rights organization, a nature protection association, a health club, a parents association, a senior association, a citizen initiative, other association, a union or a political party. I control for a set of variables, such as age groups, health status, family formation, employment situation, home owner ship, being born in Germany, presence or absence of children and household income.

I analyze individuals in the age of 18 to 89 years. The reference group is the youngest age category 18-29. The other groups are: 30-44 years, 45-59 years, 60-74 years and 75-89 years. In reference to good health, I present effects of fair and bad health conditions. The type of family formation is controlled, as follows: while status married is used as

a reference, other characteristics are separated, widowed, divorced, and single. The employment status is used like that: full time employment, part time employment, marginal employed, and non-employed. The last category includes the unemployed and pensioners. Home ownership is a dummy variable for owning a house or a flat, or not. It captures wealth effects. Being born in Germany is a proxy for non-migration. The information of children is used, as well. Relative to no children, the categories are children at home, or children not at home. This is a proxy for having younger or older children. To analyze income effects, I use monthly household income in Euros. Individuals without any household income are excluded from the analysis. Finally, I control for the German federal states. The reference state is Hamburg. Here the Saarland and Rhineland-Palatinate, as well as the Eastern and Western parts of Berlin are aggregated[5].

The most of these controls are typical variables in life satisfaction estimations. I do not discuss their directions and refer to book chapters or paper such as Argyle (1999), Blanchflower (2009) or Humpert (2010, 2013).

For the regressions I use a simple probit estimation technique with ALLBUS sample weights. Because of the binary information on life satisfaction I am able to present marginal effects of the coefficients[6]. Keeping all constant, this is the percentage change when a dummy turns from zero to one. In other words the direct membership effect on life satisfaction. The general estimation equation is like that:

$$life\ satisfaction_i = a_0 + a_1\ membership_i + X_i\ b + \varepsilon_i \quad (1)$$

For every individual *i* the life satisfaction is regressed on specific dummies of social participation activities ($a_1\ membership_i$) and on a vector of individual social-economic characteristics $X_i\ b$. Epsilon (ε_i) presents the residuum.

4. Estimations and Results

The first result is that both gender and age groups differ obviously in their participation. The descriptive statistics show that 30 percent of the males and 26 percent of the females are members of sports clubs. This is the highest share of all kinds of organizations. Here the mean age for men is 47 and 49 for women. The next highest shares are union memberships, where 17 percent of males and 9.5 percent of females participate. The mean age is 50 years for both. Concerning classical hobbies, 14 percent of men (mean age 50) and 7 percent of women (mean age 55) are member of hobby societies. Cultural societies are joined by 11 percent of the males (mean age 53) and 14 percent of the females (mean age 50). The

[5] It is obvious that size or quality of social networks may improve satisfaction as well. So for robustness reasons I tried the size of the social network members as additional variable in the regression. Unfortunately, the number of observations lower to the halve. The effects discussed above remain for the most of the activities. However, membership in health clubs is dropped because of co-linearity with self-reported state of health.

[6] The marginal effects are computed with the dprobit command implemented in STATA.

residual category of other associations has shares of 10.5 percent of males (mean age 52) and 6 percent of females (mean age 53), respectively. Charity organizations are joined by 8.5 percent of the men (mean age 55) and 10 percent of the women (mean age 59). All other kinds of activities and associations have much lower shares. Concerning nature protection societies, 6 percent of the male and 7 percent of the female population are associated with these organizations. The mean ages are close to each other (males 49; females 50). Only 5 percent of males (mean age 52) and 3 percent of the females (mean age 56) are members of political parties. Health clubs are joined by 4 percent of the men and 6 percent of the women. The mean age is 50 for both. Human rights associations have low shares. Males participate with only 1 percent and women with 2 percent. Here the clearest age differences are observable. Mean age for males is 42 and 53 for females. Citizen associations, which are founded only in special cases, are joined by 2 percent of males (mean age 54) and 1 percent of females (mean age 55). The last two groups are somewhat different. Parental and senior associations are age and gender sensible groups, because children are more related to younger individuals and mothers, while seniors activities are related to the elderly. Here 2 percent of males and 5 percent of females participate. The mean ages are 45 (males) to 43 years (females). It is not surprising, that senior associations have the oldest members. Both sexes join these association by 2 percent, with mean ages from 70 (males) to 68 (females).

This section turns to the regression in Table 3 and 4. In general only a small number of memberships lead to significant effects on life satisfaction. The results of the probit estimations of binary life satisfaction are structured like that: the tables have thirteen columns for the different social participation activities. The last column shows the results for all thirteen activities together.

Table 3: Life Satisfaction males

Culture Society	0.03616												0.02706
	(0.04165)												(0.04319)
Sports Club		0.00300											-0.01830
		(0.03167)											(0.03218)
Hobby Society			0.10023***										0.10151***
			(0.03099)										(0.03072)
Charity Organization				0.08593**									0.08647**
				(0.04280)									(0.04361)
Human Rights Organization					-0.10994								-0.24268
					(0.20023)								(0.21405)
Nature Association						0.07482							0.09392**
						(0.05167)							(0.04422)
Health Club							0.08347						0.07947
							(0.05444)						(0.05467)
Parents Association								0.07102					0.07246
								(0.08460)					(0.07341)
Senior Association									-0.04371				-0.10686
									(0.10296)				(0.11188)
Citizens Initiative										-0.02547			-0.12927
										(0.12117)			(0.13563)
other Association											-0.05072		-0.06412
											(0.04706)		(0.04925)
Union												0.01373	0.00955
												(0.03575)	(0.03613)
Political Party													0.02333	0.02469
													(0.06906)	(0.06538)
Pseudo R2	0.2325	0.2320	0.2382	0.2347	0.2324	0.2335	0.2332	0.2327	0.2321	0.2320	0.2328	0.2321	0.2321	0.2481

Source: ALLBUS 2010 (GESIS, 2012)

Note: Own calculation, Probit Estimation with marginal Effects, Levels of Significance: * p<0.05,** p<0.01,*** p<0.001, N=1,077. Controls not reported.

Table 4: Life Satisfaction females

Culture Society	0.04735												0.02853
	(0.03789)												(0.03995)
Sports Club		0.05819*											0.05458*
		(0.03051)											(0.03019)
Hobby Society			0.03598										0.02772
			(0.05074)										(0.05229)
Charity Organization				0.05035									0.03156
				(0.04137)									(0.04546)
Human Rights Organization					-0.01885								-0.09703
					(0.13026)								(0.17176)
Nature Association						0.02013							0.01004
						(0.04949)							(0.05608)
Health Club							0.02615						-0.00147
							(0.05534)						(0.06166)
Parents Association								0.12578***					0.11806**
								(0.04437)					(0.04754)
Senior Association									0.02171				-0.03818
									(0.07842)				(0.09756)
Citizens Initiative										0.14873***			0.14800***
										(0.05067)			(0.04744)
other Association											0.01934		0.01407
											(0.05806)		(0.05818)
Union												-0.09787*	-0.10726*
												(0.05323)	(0.05544)
Political Party													0.08121	0.04782
													(0.05894)	(0.06759)
Pseudo R2	0.2161	0.2178	0.2153	0.2160	0.2149	0.2150	0.2150	0.2185	0.2149	0.2163	0.2150	0.2178	0.2157	0.2281

Source: ALLBUS 2010 (GESIS, 2012)
Note: Own calculation, Probit Estimation with marginal Effects, Levels of Significance: * p<0.05,** p<0.01,*** p<0.001, N=1,051. Controls not reported.

In Table 3 the marginal effects for males are presented[7]. A membership of a hobby club increase male life satisfaction significant by 10 percent. A charity organization has a positive and significant effect of 9 percent. All other activities and organizations have no statistical effect on male life satisfaction.

In the estimation with all social participation activities together, the effects remain, but the membership in a nature protection organization turn into significance, as well. In this specification, a hobby club membership increase satisfaction by 10 percent, while a charity organization membership increases satisfaction by 9 percent. Now the membership in a nature protection association led to a 9 percent increase in satisfaction. All other organizations have no effects.

Table 4 shows the results for the females. There is a statistical significant effect of a sports club membership. Women have an increase in life satisfaction by 6 percent. Additionally women have strong positive effects in life satisfaction by memberships of a parental organization and a citizen initiative. Parental organizations increase satisfaction by 12.5 percent and citizen initiatives by 15 percent. The membership in a trade union has a significant negative effect on satisfaction. Female union members suffer from a decrease in satisfaction in terms of 10 percent. All other memberships have no effect on life satisfaction.

The estimation with all social participation activities included together supports these results. The membership in a sports club increase female satisfaction by 5.5 percent. Parental organizations increase satisfaction by 12 percent and citizen initiatives by 15 percent. Union member have a decrease in satisfaction by 11 percent.

5. Conclusion

In this paper I try to analyze if and how a membership of a social activity organization affects the personal life satisfaction. As discussed earlier, different kinds of participation, especially active or passive ones, have different strong impacts on life satisfaction. Lyubomirsky et al. (2005) show that intentional activities, with replicated investments of own effort, can substantially improve life satisfaction. Concerning gender effects Kroll (2011) show that women and especially mothers invest more often in civic engagements and profit than men. While Meier and Stutzer (2008) show that intrinsic motivated individuals are more often participating, Widjaja (2010) discusses that men and women have similar intensities of intrinsic, but different intensities of extrinsic motivations. So, men may be more interested in goals of extrinsic activities.

Some of the analyzed memberships are political or welfare activities, others are more leisure time orientated. It is obvious that these organized groups differ in their goals and beliefs, but there are comparable in general. Physical activities improve satisfaction on one hand because of the pure activity, on the the other hand because of social interactions. Interaction itself is a key reason for differences between passive memberships and active

[7] The dependent variables have the typical directions of satisfaction estimations. Full results are presented at the end of the paper in Tables AI and AII.

participation. At last, caring and giving, such as donations and participation in charity organizations improve satisfaction, as well. It is obvious that passive memberships, such as of a political party, or a human rights organization have no effects on life satisfaction, while more direct activities, such as sports or hobbies have positive effects.

In general, the results may be interpreted in that way, that activities or memberships with influence in local fields with own responsibility and personal interest in a short of time, may be more satisfying that activities with more idealists tasks and long run results, such as protecting the nature or the human rights.

6. Limitations of the study

There are some limitations of the study above. E.g. the number of some observations is relatively small. The main limitation is that only membership itself is observable in the data. Neither the intensity of participation, nor the size of membership fees are included. An other limitation is on causality. Only panel data and panel methods could shed some light on the directions of the effects. So problems of unobserved heterogeneity can not be solved.

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Appendix

Table AI: Life Satisfaction – Male (all Controls)

Age 30-44	-0.12900**	-0.12949**	-0.13941**	-0.13044**	-0.12988**	-0.12586**	-0.12698**	-0.13139**	-0.12853**	-0.12924**	-0.12827**	-0.13044**	-0.13037**	-0.13619**
	(0.05845)	(0.05846)	(0.05896)	(0.05824)	(0.05848)	(0.05817)	(0.05838)	(0.05858)	(0.05857)	(0.05855)	(0.05837)	(0.05848)	(0.05863)	(0.05804)
Age 45-59	-0.16110**	-0.15972**	-0.16903**	-0.15841**	-0.16023**	-0.15642**	-0.15825**	-0.15915**	-0.15882**	-0.16014**	-0.15837**	-0.16165**	-0.16062**	-0.16297**
	(0.06629)	(0.06644)	(0.06673)	(0.06577)	(0.06624)	(0.06645)	(0.06627)	(0.06612)	(0.06635)	(0.06636)	(0.06623)	(0.06653)	(0.06614)	(0.06683)
Age 60-74	0.04655	0.04905	0.04402	0.05036	0.04803	0.05110	0.05308	0.05120	0.05049	0.04867	0.04815	0.04789	0.04928	0.04840
	(0.06854)	(0.06819)	(0.06870)	(0.06750)	(0.06824)	(0.06771)	(0.06771)	(0.06780)	(0.06825)	(0.06830)	(0.06835)	(0.06829)	(0.06813)	(0.06790)
Age 75-89	0.11508**	0.11572**	0.11164*	0.11109*	0.11444**	0.11777**	0.11900**	0.11701**	0.11970**	0.11531**	0.11302*	0.11407**	0.11543**	0.11483**
	(0.05748)	(0.05729)	(0.05844)	(0.05813)	(0.05755)	(0.05630)	(0.05620)	(0.05669)	(0.05634)	(0.05739)	(0.05821)	(0.05786)	(0.05734)	(0.05659)
Born in Germany	0.04186	0.04463	0.03302	0.04366	0.04579	0.04005	0.04176	0.04244	0.04497	0.04510	0.04897	0.04560	0.04379	0.02849
	(0.04337)	(0.04358)	(0.04299)	(0.04358)	(0.04360)	(0.04313)	(0.04324)	(0.04333)	(0.04345)	(0.04347)	(0.04378)	(0.04348)	(0.04340)	(0.04304)
House Owner	0.08946***	0.09037***	0.08969***	0.08937***	0.08893***	0.09166***	0.08979***	0.08921***	0.09102***	0.09165***	0.09355***	0.09024***	0.08957***	0.09149***
	(0.03408)	(0.03406)	(0.03395)	(0.03383)	(0.03408)	(0.03406)	(0.03409)	(0.03429)	(0.03417)	(0.03411)	(0.03420)	(0.03416)	(0.03417)	(0.03305)
Fair Health	-0.13966***	-0.14023***	-0.14065***	-0.14391***	-0.13961***	-0.13980***	-0.14107***	-0.13927***	-0.14053***	-0.14094***	-0.13748***	-0.14071***	-0.14012***	-0.14242***
	(0.03657)	(0.03659)	(0.03647)	(0.03683)	(0.03656)	(0.03661)	(0.03661)	(0.03634)	(0.03665)	(0.03653)	(0.03647)	(0.03663)	(0.03658)	(0.03642)
Bad Health	-0.34267***	-0.34022***	-0.34249***	-0.34351***	-0.34028***	-0.34298***	-0.34343***	-0.34019***	-0.33940***	-0.34127***	-0.34043***	-0.34139***	-0.34049***	-0.35267***
	(0.05255)	(0.05238)	(0.05245)	(0.05259)	(0.05242)	(0.05250)	(0.05236)	(0.05218)	(0.05249)	(0.05228)	(0.05238)	(0.05237)	(0.05230)	(0.05294)
Secondary School	-0.06484	-0.06437	-0.06777	-0.06251	-0.06390	-0.06435	-0.06241	-0.06331	-0.06468	-0.06360	-0.06685	-0.06450	-0.06410	-0.06977
	(0.11557)	(0.11578)	(0.11552)	(0.11634)	(0.11612)	(0.11555)	(0.11571)	(0.11549)	(0.11569)	(0.11575)	(0.11538)	(0.11561)	(0.11587)	(0.11537)
O-Level	0.00740	0.00872	-0.00065	0.00319	0.01011	0.00868	0.00974	0.00718	0.00925	0.01050	0.00433	0.00840	0.00895	-0.01058
	(0.10973)	(0.10962)	(0.11026)	(0.11091)	(0.10997)	(0.10954)	(0.10969)	(0.10980)	(0.10961)	(0.10965)	(0.10971)	(0.10962)	(0.10989)	(0.11068)
Advanced Certificate	-0.00648	-0.00652	-0.01395	-0.00829	-0.00644	-0.00967	-0.01051	-0.01053	-0.00592	-0.00565	-0.00717	-0.00805	-0.00550	-0.03163
	(0.12135)	(0.12166)	(0.12334)	(0.12249)	(0.12203)	(0.12248)	(0.12293)	(0.12286)	(0.12143)	(0.12151)	(0.12118)	(0.12223)	(0.12149)	(0.12733)
A-Level	0.10561	0.10718	0.10710	0.10198	0.11044	0.10159	0.10615	0.10612	0.10715	0.10840	0.10334	0.10789	0.10655	0.09214
	(0.09511)	(0.09483)	(0.09419)	(0.09632)	(0.09467)	(0.09581)	(0.09511)	(0.09488)	(0.09486)	(0.09460)	(0.09514)	(0.09461)	(0.09507)	(0.09605)

Part Time Work	-0.03447	-0.03280	-0.03453	-0.02953	-0.03162	-0.03173	-0.02928	-0.03440	-0.03238	-0.02962	-0.03467	-0.03082	-0.03336	-0.01821
	(0.09620)	(0.09589)	(0.09626)	(0.09571)	(0.09564)	(0.09574)	(0.09505)	(0.09597)	(0.09568)	(0.09412)	(0.09624)	(0.09558)	(0.09658)	(0.09064)
Marginal Work	-0.07311	-0.07714	-0.07531	-0.08172	-0.07873	-0.07624	-0.07632	-0.07580	-0.07361	-0.07737	-0.07451	-0.07559	-0.07984	-0.07016
	(0.09779)	(0.09816)	(0.09616)	(0.09930)	(0.09839)	(0.09845)	(0.09878)	(0.09760)	(0.09821)	(0.09820)	(0.09655)	(0.09778)	(0.09937)	(0.09848)
No Work	-0.17677***	-0.17763***	-0.17743***	-0.17672***	-0.17750***	-0.17534***	-0.17950***	-0.17786***	-0.17671***	-0.17748***	-0.17849***	-0.17622***	-0.17824***	-0.17348***
	(0.05073)	(0.05071)	(0.05089)	(0.05059)	(0.05071)	(0.05071)	(0.05103)	(0.05048)	(0.05083)	(0.05077)	(0.05078)	(0.05072)	(0.05085)	(0.05096)
Separated	-0.14410	-0.14735	-0.14994	-0.13862	-0.14482	-0.14464	-0.15483	-0.14281	-0.14894	-0.14852	-0.14617	-0.14559	-0.14625	-0.13649
	(0.10807)	(0.10859)	(0.11132)	(0.10675)	(0.10919)	(0.10821)	(0.10997)	(0.10790)	(0.10882)	(0.10896)	(0.10785)	(0.10873)	(0.10860)	(0.10944)
Widow	-0.05365	-0.05158	-0.05263	-0.06156	-0.05211	-0.04817	-0.05141	-0.05022	-0.05111	-0.05165	-0.04102	-0.05164	-0.05233	-0.04539
	(0.08235)	(0.08145)	(0.08262)	(0.08379)	(0.08154)	(0.08103)	(0.08142)	(0.08109)	(0.08151)	(0.08145)	(0.07749)	(0.08184)	(0.08152)	(0.08086)
Divorced	-0.19728***	-0.19999***	-0.19473***	-0.19640***	-0.20141***	-0.20261***	-0.20093***	-0.19573***	-0.19961***	-0.19927***	-0.20118***	-0.19984***	-0.20009***	-0.19433***
	(0.07027)	(0.07062)	(0.07051)	(0.07081)	(0.07046)	(0.07092)	(0.07026)	(0.07030)	(0.07050)	(0.07036)	(0.07055)	(0.07037)	(0.07060)	(0.07012)
Single	-0.00027	-0.00117	-0.00297	0.00286	-0.00136	0.00329	0.00084	0.00323	-0.00031	-0.00278	-0.00103	-0.00101	-0.00034	0.00503
	(0.05237)	(0.05240)	(0.05182)	(0.05165)	(0.05229)	(0.05181)	(0.05210)	(0.05202)	(0.05226)	(0.05291)	(0.05230)	(0.05226)	(0.05222)	(0.05125)
Kids out of Home	-0.05818	-0.05769	-0.05564	-0.05178	-0.05705	-0.05549	-0.05805	-0.05659	-0.05785	-0.05941	-0.05742	-0.05804	-0.05670	-0.05478
	(0.05364)	(0.05363)	(0.05309)	(0.05284)	(0.05360)	(0.05327)	(0.05344)	(0.05332)	(0.05362)	(0.05470)	(0.05360)	(0.05356)	(0.05370)	(0.05305)
Kids at Home	0.00262	0.00310	-0.00196	0.00131	0.00390	0.00388	0.00152	0.00411	0.00340	0.00194	0.00591	0.00346	0.00410	-0.00501
	(0.04526)	(0.04545)	(0.04518)	(0.04503)	(0.04527)	(0.04530)	(0.04530)	(0.04522)	(0.04536)	(0.04564)	(0.04536)	(0.04532)	(0.04541)	(0.04486)
HH Income	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Culture Society	0.03616													0.02706
	(0.04165)													(0.04319)
Sports Club		0.00300												-0.01830
		(0.03167)												(0.03218)
Hobby Society			0.10023***											0.10151***
			(0.03099)											(0.03072)
Charity Organization				0.08593**										0.08647**
				(0.04280)										(0.04361)

Human Rights Organization					-0.10994									-0.24268
					(0.20023)									(0.21405)
Nature Association						0.07482								0.09392**
						(0.05167)								(0.04422)
Health Club							0.08347							0.07947
							(0.05444)							(0.05467)
Parents Association								0.07102						0.07246
								(0.08460)						(0.07341)
Senior Association									-0.04371					-0.10686
									(0.10296)					(0.11188)
Citizens Initiative										-0.02547				-0.12927
										(0.12117)				(0.13563)
other Association											-0.05072			-0.06412
											(0.04706)			(0.04925)
Union												0.01373		0.00955
												(0.03575)		(0.03613)
Political Party													0.02333	0.02469
													(0.06906)	(0.06538)
Pseudo R2	0.2325	0.2320	0.2382	0.2347	0.2324	0.2335	0.2332	0.2327	0.2321	0.2320	0.2328	0.2321	0.2321	0.2481

Source: ALLBUS 2010 (GESIS, 2012)

Note: Own calculation, Probit Estimation with marginal Effects, Levels of Significance: * p<0.05,** p<0.01,*** p<0.001, N=1,077.

Table AII: Life Satisfaction – Female (all Controls)

Age 30-44	-0.12220**	-0.12257**	-0.12350**	-0.12410**	-0.12253**	-0.12390**	-0.12384**	-0.12852**	-0.12273**	-0.12090**	-0.12306**	-0.11599*	-0.12333**	-0.11898**
	(0.06016)	(0.06009)	(0.06026)	(0.06033)	(0.06035)	(0.06058)	(0.06044)	(0.06016)	(0.06029)	(0.06008)	(0.06040)	(0.05986)	(0.06046)	(0.05978)
Age 45-59	-0.04842	-0.05018	-0.05129	-0.05842	-0.05132	-0.05546	-0.05276	-0.05300	-0.05248	-0.05156	-0.05274	-0.04596	-0.05079	-0.03929
	(0.05744)	(0.05707)	(0.05712)	(0.05767)	(0.05693)	(0.05707)	(0.05721)	(0.05667)	(0.05719)	(0.05702)	(0.05727)	(0.05696)	(0.05708)	(0.05622)
Age 60-74	0.10083*	0.10019*	0.10010*	0.09471*	0.10123*	0.09854*	0.10043*	0.09683*	0.10037*	0.09959*	0.10069*	0.10363*	0.10019*	0.09795*
	(0.05448)	(0.05400)	(0.05454)	(0.05521)	(0.05421)	(0.05465)	(0.05441)	(0.05434)	(0.05448)	(0.05431)	(0.05445)	(0.05395)	(0.05467)	(0.05361)
Age 75-89	0.07799	0.08057	0.07626	0.07112	0.07739	0.07508	0.07644	0.07077	0.07665	0.07476	0.07728	0.07828	0.07773	0.07589
	(0.05474)	(0.05380)	(0.05498)	(0.05606)	(0.05480)	(0.05518)	(0.05489)	(0.05572)	(0.05488)	(0.05511)	(0.05475)	(0.05436)	(0.05474)	(0.05408)
Born in Germany	-0.00065	-0.00354	0.00054	-0.00178	0.00137	0.00054	0.00108	-0.00073	0.00143	0.00107	0.00143	0.00546	0.00004	-0.00650
	(0.03883)	(0.03842)	(0.03861)	(0.03839)	(0.03873)	(0.03884)	(0.03871)	(0.03835)	(0.03877)	(0.03867)	(0.03876)	(0.03904)	(0.03864)	(0.03773)
House Owner	0.06988**	0.07057**	0.07178**	0.07299**	0.07398**	0.07249**	0.07356**	0.07491**	0.07296**	0.07281**	0.07343**	0.07505**	0.07284**	0.06944**
	(0.03143)	(0.03161)	(0.03101)	(0.03142)	(0.03143)	(0.03132)	(0.03137)	(0.03138)	(0.03147)	(0.03126)	(0.03132)	(0.03126)	(0.03131)	(0.03115)
Fair Health	-0.16307***	-0.16110***	-0.16081***	-0.16062***	-0.16146***	-0.16041***	-0.16182***	-0.16111***	-0.16157***	-0.16146***	-0.16203***	-0.15727***	-0.16157***	-0.15901***
	(0.03804)	(0.03792)	(0.03788)	(0.03781)	(0.03774)	(0.03776)	(0.03798)	(0.03780)	(0.03797)	(0.03784)	(0.03768)	(0.03768)	(0.03790)	(0.03748)
Bad Health	-0.33379***	-0.32562***	-0.33056***	-0.33105***	-0.33138***	-0.32935***	-0.33179***	-0.32882***	-0.33119***	-0.32733***	-0.33158***	-0.32728***	-0.32899***	-0.32032***
	(0.04974)	(0.04948)	(0.04938)	(0.04954)	(0.04945)	(0.04947)	(0.04960)	(0.04963)	(0.04948)	(0.04948)	(0.04935)	(0.04934)	(0.04947)	(0.04984)
Secondary School	-0.01835	-0.01650	-0.01422	-0.01946	-0.01586	-0.01582	-0.01696	-0.01893	-0.01629	-0.01757	-0.01669	-0.01063	-0.01792	-0.02004
	(0.10239)	(0.10152)	(0.10137)	(0.10249)	(0.10189)	(0.10192)	(0.10206)	(0.10162)	(0.10199)	(0.10172)	(0.10204)	(0.10109)	(0.10222)	(0.10105)
O-Level	0.01759	0.01894	0.02494	0.01832	0.02333	0.02282	0.02123	0.01878	0.02310	0.02237	0.02246	0.02957	0.02242	0.01571
	(0.10091)	(0.10008)	(0.09951)	(0.10082)	(0.10003)	(0.10011)	(0.10027)	(0.09997)	(0.10007)	(0.09980)	(0.10020)	(0.09905)	(0.10024)	(0.09966)
Advanced Certificate	0.08149	0.07862	0.08750	0.08294	0.08494	0.08568	0.08377	0.07972	0.08489	0.08364	0.08315	0.09112	0.08510	0.07640
	(0.08794)	(0.08923)	(0.08468)	(0.08728)	(0.08617)	(0.08578)	(0.08675)	(0.08798)	(0.08624)	(0.08638)	(0.08708)	(0.08310)	(0.08614)	(0.08926)
A-Level	0.11532	0.11444	0.12375	0.11927	0.12304	0.12033	0.12120	0.11692	0.12194	0.12075	0.12154	0.12679	0.12067	0.11032
	(0.08444)	(0.08387)	(0.08171)	(0.08313)	(0.08231)	(0.08296)	(0.08258)	(0.08274)	(0.08242)	(0.08222)	(0.08250)	(0.08081)	(0.08269)	(0.08382)
Part Time Work	0.01429	0.01216	0.01438	0.01447	0.01696	0.01657	0.01648	0.01239	0.01683	0.01618	0.01631	0.01499	0.01794	0.00041
	(0.04202)	(0.04219)	(0.04203)	(0.04193)	(0.04181)	(0.04174)	(0.04189)	(0.04216)	(0.04180)	(0.04173)	(0.04194)	(0.04176)	(0.04169)	(0.04287)

Marginal Work	-0.06543	-0.06334	-0.06211	-0.06352	-0.06334	-0.06166	-0.06318	-0.06178	-0.06244	-0.06445	-0.06335	-0.07358	-0.06466	-0.07934
	(0.06279)	(0.06215)	(0.06233)	(0.06229)	(0.06243)	(0.06209)	(0.06234)	(0.06191)	(0.06228)	(0.06227)	(0.06242)	(0.06373)	(0.06276)	(0.06415)
No Work	-0.00717	-0.00905	-0.00843	-0.00946	-0.00761	-0.00746	-0.00862	-0.00586	-0.00768	-0.00729	-0.00844	-0.01334	-0.00904	-0.01602
	(0.04336)	(0.04348)	(0.04352)	(0.04335)	(0.04338)	(0.04331)	(0.04332)	(0.04329)	(0.04341)	(0.04325)	(0.04342)	(0.04346)	(0.04346)	(0.04340)
Separated	-0.21019	-0.19855	-0.20799	-0.20823	-0.20742	-0.20853	-0.20819	-0.20256	-0.20617	-0.21595	-0.20583	-0.21364	-0.21059	-0.22300*
	(0.13168)	(0.12951)	(0.13267)	(0.13404)	(0.13219)	(0.13257)	(0.13273)	(0.13136)	(0.13203)	(0.13326)	(0.13210)	(0.13390)	(0.13199)	(0.13514)
Widow	0.01695	0.01262	0.01752	0.01688	0.01692	0.01696	0.01713	0.01843	0.01660	0.02051	0.01669	0.01589	0.01782	0.01878
	(0.04473)	(0.04520)	(0.04452)	(0.04463)	(0.04448)	(0.04473)	(0.04464)	(0.04404)	(0.04467)	(0.04428)	(0.04468)	(0.04467)	(0.04455)	(0.04359)
Divorced	-0.06933	-0.06861	-0.06936	-0.06256	-0.06808	-0.06825	-0.06919	-0.06717	-0.06750	-0.06599	-0.06806	-0.06441	-0.06688	-0.05879
	(0.04948)	(0.04912)	(0.04941)	(0.04890)	(0.04935)	(0.04930)	(0.04944)	(0.04897)	(0.04932)	(0.04910)	(0.04927)	(0.04909)	(0.04932)	(0.04845)
Single	0.02780	0.02885	0.03073	0.02892	0.03074	0.02931	0.03009	0.02882	0.03044	0.03083	0.02948	0.03217	0.02882	0.02973
	(0.04497)	(0.04470)	(0.04470)	(0.04474)	(0.04481)	(0.04485)	(0.04479)	(0.04447)	(0.04473)	(0.04455)	(0.04486)	(0.04436)	(0.04486)	(0.04378)
Kids out of Home	0.08113**	0.08102**	0.08357**	0.07909**	0.08169**	0.08137**	0.08229**	0.06528	0.08177**	0.08029**	0.08156**	0.08132**	0.08192**	0.06454
	(0.04005)	(0.04017)	(0.03987)	(0.04022)	(0.04009)	(0.04000)	(0.04010)	(0.04173)	(0.04009)	(0.04005)	(0.04013)	(0.03976)	(0.04002)	(0.04125)
Kids at Home	0.10004**	0.10105**	0.10191**	0.09964**	0.10203**	0.10283**	0.10139**	0.09767**	0.10212**	0.10067**	0.10126**	0.10370**	0.10003**	0.09301**
	(0.04307)	(0.04319)	(0.04303)	(0.04299)	(0.04298)	(0.04291)	(0.04293)	(0.04262)	(0.04300)	(0.04287)	(0.04307)	(0.04273)	(0.04303)	(0.04259)
HH Income	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***	0.00008***
	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Culture Society	0.04735													0.02853
	(0.03789)													(0.03995)
Sports Club		0.05819*												0.05458*
		(0.03051)												(0.03019)
Hobby Society			0.03598											0.02772
			(0.05074)											(0.05229)
Charity Organization				0.05035										0.03156
				(0.04137)										(0.04546)
Human Rights Organization					-0.01885									-0.09703
					(0.13026)									(0.17176)

Nature Association						0.02013								0.01004
						(0.04949)								(0.05608)
Health Club							0.02615							-0.00147
							(0.05534)							(0.06166)
Parents Association								0.12578***						0.11806**
								(0.04437)						(0.04754)
Senior Association									0.02171					-0.03818
									(0.07842)					(0.09756)
Citizens Initiative										0.14873***				0.14800***
										(0.05067)				(0.04744)
other Association											0.01934			0.01407
											(0.05806)			(0.05818)
Union												-0.09787*		-0.10726*
												(0.05323)		(0.05544)
Political Party													0.08121	0.04782
													(0.05894)	(0.06759)
Pseudo R2	0.2161	0.2178	0.2153	0.2160	0.2149	0.2150	0.2150	0.2185	0.2149	0.2163	0.2150	0.2178	0.2157	0.2281

Source: ALLBUS 2010 (GESIS, 2012)

Note: Own calculation, Probit Estimation with marginal Effects, Levels of Significance: * p<0.05,** p<0.01,*** p<0.001, N=1,051.

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