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Challenging the popular wisdom. New estimates of the unobserved economy[*]

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Abstract

We estimate the unrecorded economy in 49 economies from 1981 to 2005. Our study is based on electricity consumption series which are filtered to account for technological change and for the changing weight of the energy-intensive industrial sector. In contrast with studies based on the MIMIC method, we obtain a reduction in the weight of the unobserved economy. Unlike La Porta and Shleifer (2008), we identify measures of institutional quality which are significantly related to the shadow economy even after controlling for per-capita GDP. Thus the shadow economy should not be dismissed as the unpleasant side effect of underdevelopment. Instead it is related to some specific institutional aspects that may well survive even when the economy reaches higher development stages. We identify strong substitution effects between official and unofficial sectors both in the long run and over the business cycle. This has important implications for income convergence and for the relationship between volatility and growth.

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1 Introduction

The unobserved or shadow economy accounts for between a third and a half of total GDP in developing countries (La Porta and Shleifer, 2008). Even in developed countries like Italy and Spain, recent estimates set the weight of the shadow economy at around 20% (Dell'Anno, 2003; Alañón-Pardo and Gómez-Antonio, 2005). Economists disagree about the determinants and the effects of the unofficial sector. De Soto (1989, 2000) argues that excessive taxes and regulations confine firms to the fringe of markets, limiting access to public goods and wasting their productive potential. Others (Farrell, 2004; Farrell, Baily and Remes, 2005) see informal firms as gaining a substantial cost advantage relative to official firms. Finally, La Porta and Shleifer (2008) look at the formal and informal sectors as two parallel economies, where the inefficient informal sector is bound to recede when growth-enhancing policies raise the quality of the public goods accessible to official firms.

Empirical analysis is obviously crucial for a better understanding of the phenomenon. Researchers [1] who adopt the Multiple Indicators and Multiple Causes (MIMIC) latent variable method represent the shadow economy in terms of two sets of variables, respectively labeled as "causal variables" (taxation, regulatory burden, attitudes toward the state) and "likely indicators" (changes in the demand for currency, in the labour force participation rate and in official GDP). Studies based on this approach report that the shadow economy has been on the rise since the 1990s (Schneider and Enste, 2000). The method has been criticized because the choice of "causal variables" and "likely effects" appears arbitrary (Helberger and Knepel, 1988; Smith, 2002; Hill, 2002; Breusch, 2005). Moreover, the use of variables like taxes and government regulation as determinants of the unrecorded economy leads to almost tautological results when one interprets the obtained estimates on the grounds of economic and institutional factors. Consider for instance the set of variables that identify a country's institutional quality (Kaufmann, Kraay and Mastruzzi, 2007). These are also typically related to the size of the public sector and to market regulation. Thus, measures of the unrecorded economy based on these two latter variables are bound to exhibit correlations with measures of institutional quality found in Torgler and Schneider (2007).

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[1] Loayza, 1996; Giles, 1999a, 1999b, 1999c; Chatterjee, Chaudhury and Schneider, 2003; Giles, Tedds and Werkneh, 2003; Tedds and Giles, 2002; Dell'Anno, 2003; Bajada and Schneider, 2005; Schneider, 2004, 2005, 2008; Alañón and Gómez-Antonio, 2005; Buehn, Karmann and Schneider, 2007; Dell'Anno, Gómez-Antonio and Alañón-Pardo, 2007; Brambila-Macias, 2008.

Alternatively, the Electricity Consumption (EC) approach does not require theoretical priors on the causes of the unobserved economy. In fact, it obtains the shadow economy as the difference between an estimate of total (observed and unobserved) GDP growth and official GDP figures. Estimates of total GDP growth are directly inferred from electricity consumption growth by imposing a constant electricity-consumption-to-GDP ratio. This assumption has been widely criticized (Lacko 1998, 1999; Hanousek and Palda, 2006) because it implies that the size of the informal economy will be biased down by energy-saving technological progress. Some authors have therefore chosen *ad hoc* country-specific values for the ratio of electricity consumption to GDP (Kaufmann and Kaliberda, 1996; Johnson, Kaufmann and Shleifer, 1997). More recently, Chong and Gradstein (2007) impose a 5% per-decade decrease in the elasticity of electricity consumption to GDP for all countries. Unfortunately, their method in several cases generates negative values for the relative size of the unrecorded economy (see our discussion in Section 3 below). This inevitably weakens the robustness of their conclusions about the institutional determinants of the shadow economy.

In the paper we obtain measures of the shadow economy which, unlike MIMIC estimates, are independent from theoretical priors and yet avoid the *ad hoc* assumptions that plague previous applications of the EC method. To begin with, note that the overall effects of technological change on electricity consumption are in fact ambiguous. The Jevons' Paradox suggests that the role of energy-saving innovations is probably limited (Jevons, 1865, 1965; Iorgulescu and Polimeni, 2007; Polimeni and Iorgulescu, 2007). In addition, labour-saving innovations are likely to increase energy consumption. Finally, variations in the weight of the energy-intensive industrial sector should also affect electricity consumption. We therefore apply a version of the Modified Total Electricity (MTE) approach proposed by Eilat and Zinnes (2002). This involves a two-stages procedure. In the first stage the series of electricity consumption growth is filtered to remove the influence of changes in the weight of the industry sector and in the relative electricity prices. Empirical studies (Popp, 2001, 2002; Linn, 2008) show that energy-saving technological change is mainly driven by changes in energy prices, whereas autonomous innovations play a lesser role. In the second stage, the growth rate of the shadow economy is obtained by subtracting the growth rate of the official economy from the filtered series of electricity consumption growth - where the latter proxies the growth rate of the overall economy.

We consider 49 economies over the period 1981-2005. Since the time series dimension of the

panel is significantly long, the choice of the econometric methodology is based on a preliminary analysis about the stationarity and cointegration of the variables. The application of panel unit root and cointegration techniques is an important innovative aspect of this study.

Our estimates provide a suggestive and novel description of the dynamics of the shadow economy, in contrast with pre-existing results. On the one hand, we find that the relative size of the shadow economy has decreased for most countries during the last decades. On the other hand, even if we observe a negative and statistically significant correlation between annual growth rates of official GDP and the share of unrecorded income, we identify measures of institutional quality which are significantly correlated to the shadow economy even after controlling for the effect of per-capita GDP. This latter result, in sharp contrast with La Porta and Shleifer (2008), suggests that the shadow economy should not be dismissed as the unpleasant side effect of economic underdevelopment. Instead it is related to some specific institutional aspects that may well survive even when the economy reaches higher development stages. Finally, our method allows for the first time to compute cyclical gaps in the official and unrecorded GDP figures. In line with the theoretical model of Busato and Chiarini (2004), we find evidence of a double business cycle, where the correlation between the two gaps is negative and statistically significant.

The remainder of the paper is organized as follows. Section 2 describes the model and defines the empirical methodology. Section 3 presents the results. In Section 4 we conclude and discuss the debate on income convergence and the relationship between volatility and growth.

2 Model identification, data description and econometric methodology

Any attempt to exploit electricity consumption to estimate the shadow economy should address the issue of the empirical stability of the energy-consumption-to-GDP ratio. Critics of the EC approach emphasize the potential downward bias caused by energy-saving technological change. The argument is straightforward and quite intuitive, but it neglects a long-standing debate on the Jevons' Paradox: it cannot be taken for granted that energy-saving technological change will reduce the energy intensity of aggregate production (Jevons, 1865, 1965). In fact, computable general equilibrium models support the view that energy consumption might "rebound" because energy

demand is at best weakly correlated with a more efficient energy use. The reason why this might happen is easily explained. Following an improvement in energy efficiency, market forces drive some countervailing effects: (i) the fall in energy prices triggers a substitution effect towards more energy-intensive goods and production techniques; (ii) the income effect raises household consumption of all commodities, including energy consumption. The issue ultimately is an empirical one. Simulations in Grant, Hanley, McGregor, Swales and Turner (2007) obtain a rebound effect between 30 and 50%. [2] In addition, the downward bias might be offset by other forms of technological change, such as labor-saving innovations, which increase the energy intensity of the production function. For instance, early econometric work has shown that in the US manufacturing sector technical change has been energy intensive (Jorgenson and Fraumeni, 1981; Hogan and Jorgenson, 1991). Finally, one should bear in mind that sectoral specialization might change as the economy develops, thereby affecting the energy intensity of production.

Our analysis is based on the assumption that changes in the domestic real price of electricity [3] capture the effects of supply shocks and of long term efficiency gains caused by technical change, whereas changes in the industry share of GDP affect the component of electricity consumption which is directly related to the country-specific evolution in the composition of domestic output. The first stage of our application of the MTE procedure is therefore based on the following equation:

$$\Delta Elec_{i,t} = \alpha_i + \beta_1 \Delta Eprice_{i,t} + \beta_2 \Delta IndGdp_{i,t} + \varepsilon_{i,t} \tag{1}$$

where subscripts t, i are time and country indexes, $\Delta Elec$, $\Delta Eprice$ and $\Delta IndGdp$ respectively describe annual percentage changes in electricity consumption, in the real price of electricity and in the industry share of GDP. [4]

Once the relative-price and demand-composition effects have been identified, the residual changes in electricity consumption, $\Delta Elec^{res}$, may be used as a proxy for the growth rate in the overall (recorded and unrecorded) economic activity:

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[2] Dimitropoulos (2007) reports stronger rebound effects.

[3] The use of relative electricity prices obviously raises endogeneity problems. We address them in Appendix I below.

[4] Eilat and Zinnes (2002) also consider the private sector share of total GDP, in order to capture privatization effects in transition economies. This additional factor is therefore not important for our panel, which includes only six transition economies.

$$\Delta Elec_{i,t}^{res} = \Delta Elec_{i,t} - [\beta_1 \Delta Eprice_{i,t} + \beta_2 \Delta IndGdp_{i,t}] \tag{2}$$

Then, the growth rate of the unrecorded economy, ΔSH, is obtained as follows:

$$\Delta SH_{i,t} = \Delta Elec_{i,t}^{res} - \Delta Gdp_{i,t} \tag{3}$$

where ΔGdp denotes the official GDP growth rate. Finally, by applying ΔSH to pre-existing base-year estimates, we obtain our measures of the unrecorded economy as a share of official GDP.[5]

Panel composition, 49 economies[6] over the period 1981-2005, depends on the availability of data about electricity consumption, electricity price and share of industry.[7] Data on electricity consumption, real price of electricity, share of industrial income and official GDP have been obtained from Energy Information Administration, International Energy Agency, World Bank and United Nations, respectively (see Appendix II).

Since the time series dimension of the panel is relatively long, the econometric methodology is based on a preliminary stationarity and cointegration analysis of the relevant variables. Variables $\Delta Elec$, $\Delta Eprice$, $\Delta IndGdp$ exhibit non stationarity, tested using Im, Pesaran and Shin (2003), Pesaran (2003, 2007), Hadri (2000), Kwiatkowski, Phillips, Schmidt and Shin (1992), ADF and Phillips-Perron unit root tests (see Appendix I for details). A cointegrating relationships between $\Delta Elec$, $\Delta Eprice$ and $\Delta IndGdp$ has been, therefore, detected using the residual-based procedure developed by Pedroni (1999, 2004).

Due to the presence of cointegrated time series, in our estimate of equation (1) we use the group-mean panel Fully Modified Ordinary Least Squares (FMOLS) method proposed by Pedroni (2000, 2001).[8]

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[5] We have adopted the estimates of Johnson et al. (1997)- for the transition economies- and Lacko (1996, 1998)- for the OECD and Developing countries. The base-year estimate for Tanzania is from Bagachwa and Nasho (1995).

[6] Countries in the sample are Australia, Austria, Belgium, Botswana, Bulgaria, Brazil, Canada, Chile, Colombia, Co sta Rica, Czech R., Denmark, Egypt, Finland, France, Germany, Greece, Guatemala, Hong Kong, Hungary, Ireland, Israel, Italy, Japan, Korea, Malaysia, Morocco, Mexico, Netherlands, Norway, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Singapore, Slovak R., Spain, Sri Lanka, Sweden, Switzerland, Tanzania, Tunisia, Thailand, United Kingdom, United States, and Venezuela.

[7] Due to lack of some observations about electricity consumption and the industry share, we have ruled out some of the countries for which base-year macroelectric figures were available: Azerbaijan, Belarus, Croatia, Estonia, Georgia, Kazakhstan, Lithuania, Latvia, Moldova, Russia, Ukraine, Uzbekistan, Cyprus, Mauritius, and Nigeria.

[8] See Appendix I for a detailed description of our econometric methodology.

3 Results

To gauge the relevance of the filtering procedure (2), in Figure 7 (Appendix III) we plot for each country the cumulated series for $\Delta Elec^{res}$ and $\Delta Elec$, starting from a common base (1981=100). It is easy to see that substantial and persistent differences exist for 50% of the countries in the panel. In Figure 8 (Appendix III), we provide a comparison between the EC and our MTE estimates. The MTE estimates obtained by filtering out separately the changes in electricity prices- MTE_P- and changes in output composition- MTE_I- are also reported. In some countries important differences between the two methods arise as a consequence of the changing weight of the industry share. In fact, we observe that in transition countries the standard EC method underestimates the relative size of unobserved sector after the end of communism, when the industry share of GDP decreased. A similar difference is detected in countries like Hong Kong, Italy and Japan, where the service sector as a percentage of GDP has significantly increased during the last decades. By contrast, the development process in countries like Thailand corresponds to an increase in the industry share of GDP. In this case the EC method overestimates the relative size of the unobserved sector. The relative price effect in energy consumption seems to play a lesser role: we could find important differences only for South Korea.

Table 1 presents the cross country distribution of the shadow economy (SH) and documents changes relative to the initial sample period.

Table 1 Descriptive statistics of the MTE estimates (% GDP)

Country	$SH_{2001-2005}$	Δ	Country	$SH_{2001-2005}$	Δ
AU	9.1	-8.9	KR	23.1	-52.6
AT	10.9	-5.3	MY	24.2	-22.3
BE	17.9	-7.5	MA	37.8	-10.1
BW	18.9	-63	MX	38.5	-2.2
BG	31.8	-7.9	NL	9.9	-6.6
BR	26.7	-3.5	NO	4.3	-6.5
CA	6.8	-7.2	PA	21.1	-17.6
CL	22.1	-24.4	PY	36.2	15.6
CO	18.3	-19.1	PE	30.1	-3.5
CR	19.8	-18.7	PH	46.2	-2.7
CZ	6.2	0.5	PL	12.7	-10.8
DK	12.3	-7.2	PT	16	-4.5
EG	49.1	-46.7	RO	14.1	0.4
FI	11	-4.7	SG	5.8	-12.6
FR	10.4	-3.7	SK	5.3	-0.5
DE	10.9	-8	ES	19.7	-11.1
GR	17.4	-1.3	LK	28.9	-16.6
GT	56.7	9.5	SE	7.4	-4.6
HK	10.5	-6.4	CH	9.4	-2.1
HU	29.4	-6.2	TZ	16.7	-39.2
IE	6.4	-19.6	TH	50.4	-68.1
IL	18.8	-14.1	TN	31.5	-12.7
IT	20.9	-0.1	GB	8.5	-9.5
JP	13.7	-4.2	US	6.1	-7.6
			VE	27.8	0.4

Note: $\Delta = SH_{2001-2005} \text{-} SH_{1981-1985}$

Source: own calculations.

Our results are in sharp contrast with those obtained under the MIMIC method (Schneider, 2004, 2005, reported in Figure 9, Appendix III). In fact, we find that the relative importance of the unrecorded economy has fallen in all countries with the exceptions of Guatemala, characterized by an increase, and a small group of countries where SH was substantially stable (Italy, Romania, Venezuela, the Czech and Slovak Republics). In Figure 9, we also report shadow economy estimates obtained by Chong and Gradstein (2007) who adopt the EC method but impose a 5% per-decade decrease in the elasticity of electricity consumption to GDP. [9] It is interesting to note that, for all their emphasis on energy-saving technical change, in several countries our estimates document a smaller reduction in SH.

To cross-check the plausibility of our results, we adopt a "narrative" approach, investigating whether episodes of institutional change, economic crisis and reform might be associated to the country-specific patterns of the unobserved economy emerging from our estimates. In Appendix IV, we provide a detailed description of our findings. As an example, it is interesting to discuss here the case of transition economies (Bulgaria, Czech Republic, Hungary, Poland, Romania and Slovakia), where our estimates depict a "hump-shaped" pattern for the dynamics of the shadow economy following the fall of the communist regime in 1989. The observed initial increase might be due to the economic and institutional disarray that followed the collapse of communism. The subsequent reversal might be related to consolidation of the state and to market-oriented reforms, based on price- and trade-liberalization measures, that were undertaken during the 1990s. [10]

In Table 2 we document some basic dynamic panel correlations of our estimates with measures of development and official output volatility. A widely cited stylized fact is that the share of the unrecorded economy is inversely related to the stage of economic development (Amaral and Quintin, 2006). The theoretical model of Loayza and Rigolini (2006) supports this views and also suggests that the share of the shadow economy should exhibit a countercyclical pattern. A similar conclusion about the cyclical substitutability between official and unrecorded activities obtains in

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[9] The Chong and Gradstein (2007) method yields negative shares of the unrecorded economy in Canada, Norway, Poland, Romania and Sweden. These figures were kindly supplied by Alberto Chong.

[10] Our results are quite similar to those obtained for transition countries by Feige and Urban (2008) using essentially similar methods. As noted by these authors, over the decades examined in our analysis, GDP accounting might have improved, reducing the amount of unrecorded income simply because of better and more inclusive national accounting techniques. Indeed, improved national income accounting could explain the declines in our estimated unrecorded income. Nevertheless, adding to our estimates the percentages of imputed unobserved income reported in Feige and Urban (2008), we found that, except for Romania in the years 1994-1996 and Slovakia in 1996, the two series follow similar dynamics.

the theoretical model of Busato and Chiarini (2004). In fact, we found that changes in SH correlate negatively with yearly growth rates of official GDP, and positively with standard development indicators such as the relative weight of agricultural production and the percentage of active labor force that is self-employed. [11] Finally, we computed cyclical gaps in the official and unrecorded GDP figures [12], obtaining evidence of a double business cycle,where the correlation between the two gaps is negative and statistically significant. As an example, Figure 1 plots official and unrecorded output gaps for United States.

Table 2- Correlation analysis

	Correlation coefficients
Δ Share unrecorded income-Official GDP growth	$-0.55***$
Share unrecorded income-Share agricultural income	$0.46***$
Share unrecorded income-Share self-employment	$0.63***$
Unofficial output gap-Official output gap[13]	$-0.39***$

Note: * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Figure 1- Official and unrecorded output gaps- United States

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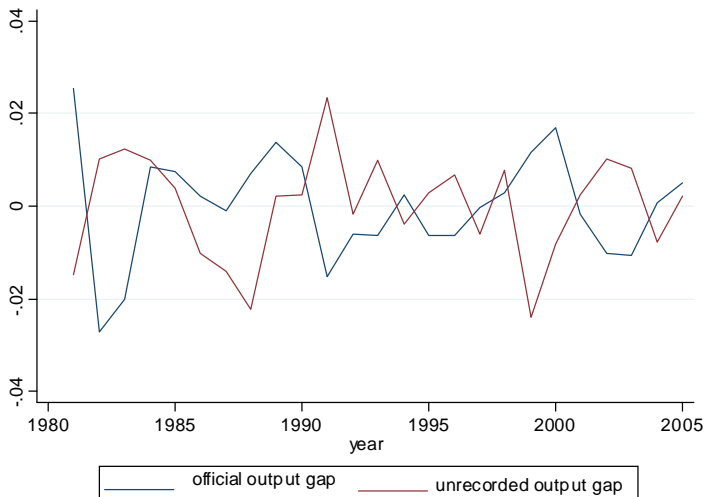
[11] As noted by Loayza and Rigolini (2006), in most developing countries there is a strong correlation between unobserved activity and self-employment, as most self employed tend to be low-skilled, unregistered workers.

[12] The two gaps are obtained detrending the series of unobserved economy and official GDP by using the Hodrick-Prescott filter.

[13] Czech and Slovak Republics are outliers and, therefore, excluded from this analysis.

3.1 Interpreting cross-country differences, preliminary results

La Porta and Shleifer (2008) group the determinants of the size of the unofficial economy into three broad categories: the cost of becoming formal, the cost of staying formal, and the benefits of being formal. Then, having identified proxies for these three categories, they explore cross-country correlations with several measures of the shadow economy. They find that most estimated coefficients fall in value and lose significance after controlling for per-capita GDP. This latter variable, in turn, is strongly significant. Their interpretation of this result is that the informal economy is a manifestation of underdevelopment, which recedes as the economy develops.

We adopt a similar approach, investigating whether measures of "institutional quality" may explain our estimates of the shadow economy. It should be noted from the outset that we are strongly constrained by data availability. In fact several measures of the costs and benefits from being formal are discontinuous and available only for the latter part of our sample. We cannot therefore exploit the time series dimension of the panel. To limit endogeneity problems the regressors[14] are predetermined to the measures of the shadow economy which, in turn, are restricted to the 2001-2005 averages in order to overlap with the sample period in La Porta and Shleifer (2008). Since the number of country observations limits our degrees of freedom, we are forced to use existing synthetic measures of the pros and cons of informality, such as the "Index of Business Freedom" (IBF) and the "Index of Trade Freedom" (ITF). We also account for a specific measure of the cost of being formal, i.e the log number of procedures required to enforce a contract ($log\ PROC$). In addition, the benefits of formality may be captured by measures of government efficiency such as the "Index of Electoral Competition" (IEC) and an index of government stability ($STABS$). We also expect that the level of human capital (captured by the variable EDU) is inversely related to the weight of the shadow economy because more educated workers are less likely to be employed by the less productive firms that operate informally. To control for the stage of economic development we include the log of per-capita income ($log\ GDP$).

All our measures of institutional quality (except for IEC) are significantly related to the shadow economy and exhibit the expected signs (Table 3). Unlike La Porta and Shleifer (2008) our results survive after controlling for the effect of per capita GDP. This suggests that the shadow economy

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[14]See Appendix II for a detailed description of the data.

should not be dismissed as the unpleasant side effect of economic underdevelopment. Instead it is related to some specific institutional aspects that may well survive even when the economy reaches higher development stages. To support intuition, in Figure 2 we show that, among OECD economies, countries like Belgium, Greece, Italy, Portugal and Spain are characterized by a relatively higher share of unrecorded income. [15] Other less developed economies, such as Tanzania and Botswana, benefit from relatively good institutional quality and are characterized by a relatively small weight of the shadow economy. [16]

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[15]Not surprisingly, these countries are also characterized by much worse average scores for *IBF* and *log PROC.*

[16]The Executive Index of Electoral Competitiveness is equal to 7 for Tanzania and Botswana. This is the largest possible score, given that the largest party got less than 75% (see Appendix II). Similarly, the measure of political stability is equal to 0 for both countries. This refers to the highest level of stability.

Table 3- OLS regressions with robust standard errors

Dependent variable: unrecorded economy (% of official GDP)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
IBF	−0.67 ∗ ∗∗	−0.4 ∗ ∗	−0.39 ∗ ∗∗	−0.43 ∗ ∗∗	−0.34 ∗ ∗	−0.27∗	−0.29 ∗ ∗
ITF		−0.57 ∗ ∗∗	−0.61 ∗ ∗∗	−0.53 ∗ ∗∗	−0.43 ∗ ∗∗	−0.28 ∗ ∗	−0.33 ∗ ∗
STABS			0.16 ∗ ∗	0.16 ∗ ∗	0.17 ∗ ∗	0.1 ∗ ∗∗	0.1 ∗ ∗∗
IEC				−0.01	−0.01	−0.01∗	−0.009
log PROC					0.16 ∗ ∗	0.16 ∗ ∗∗	0.16 ∗ ∗∗
EDU						−0.12∗	−0.16∗
log GDP							0.01

Note: regressions with constant terms and robust standard errors (not reported).

* significant at the 10% level. ** significant at the 5% level.*** significant at the 1% level.

Figure 2- Unobserved economy and GDP per capita- 2001-2005
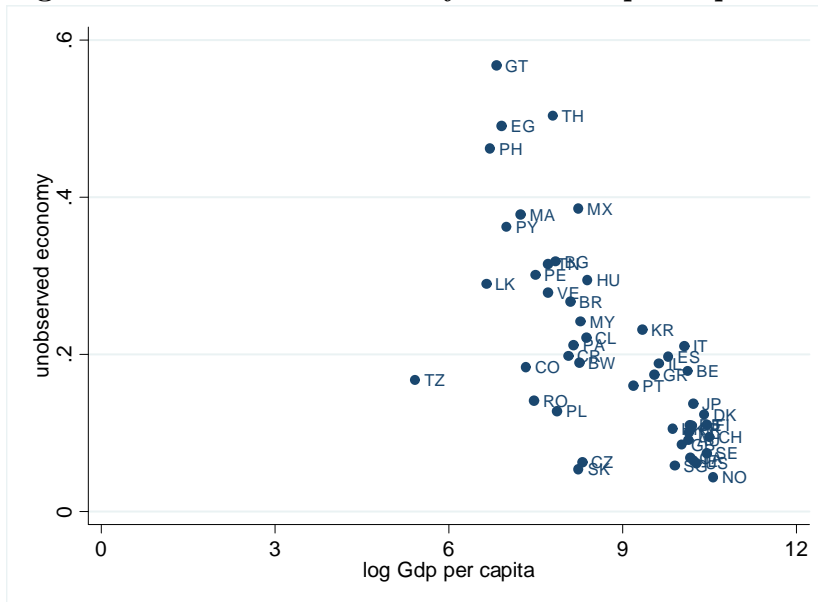
4   Conclusions and extensions

We challenge two established views, i.e. that the shadow economy has been on a rising trend over the last decades and that it is inevitably bound to recede with economic development. In fact we show that for most countries the relative size of the unobserved economy has decreased. In addition, we find that cross country differences remain correlated to measures of institutional quality even after controlling for the stage of economic development.

Our analysis has identified strong substitution effects between official and unofficial sectors both in the long run - when the share of the unrecorded economy is inversely related to official output growth - and over the business cycle. This implies an upward bias in official figures concerning per capita income growth (Figure 3). The scatter diagram reported in Figure 4 shows that this bias is stronger for poorer countries, suggesting that established results on per capita income convergence should be reconsidered.

A similar conclusion applies to empirical analyses of the link between output volatility and growth (Ramey and Ramey, 1995; Hnatkovska and Loayza, 2004; Aghion, Angeletos, Banerjee and Manova, 2005; Chatterjee and Shukayev, 2006). For each country we computed the volatility of total (observed plus unobserved) output growth for each country, finding that it is lower than official output growth volatility in 43 out of the 49 countries (Figure 5). [17] Figure 6 shows that the negative correlation between growth and volatility is much stronger if we take into account our estimates of the unrecorded economy.

Finally, since we use a measurement method which is not based on theoretical priors concerning the role of taxes and market regulations, our estimates pave the way for an investigation of the institutional determinants of the shadow economy. This is left for future research.

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[17] The remaining 6 countries are Austria, Egypt, Guatemala, Paraguay, Sri Lanka and Tanzania.

Figure 3- Official and total per capita GDP growth- 1981-2005
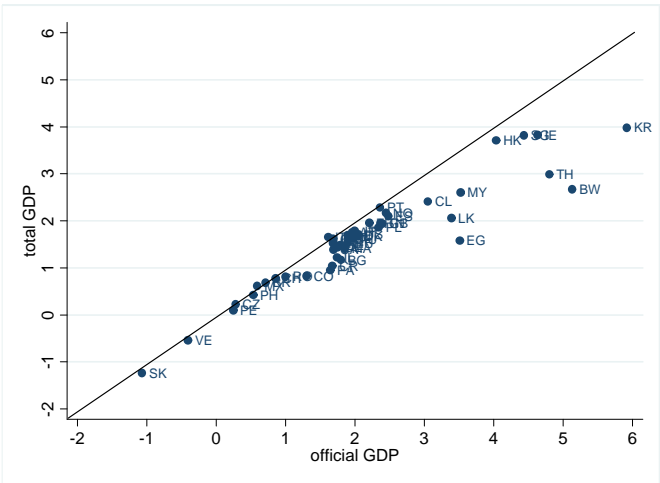
Figure 4
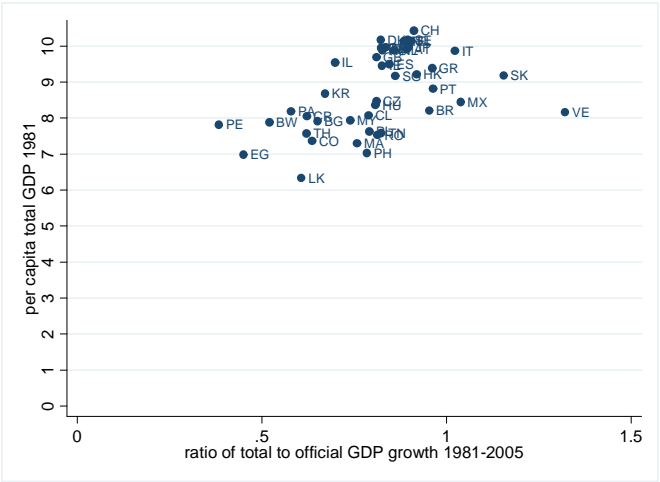
Figure 5- Official and total output growth volatility- 1981-2005
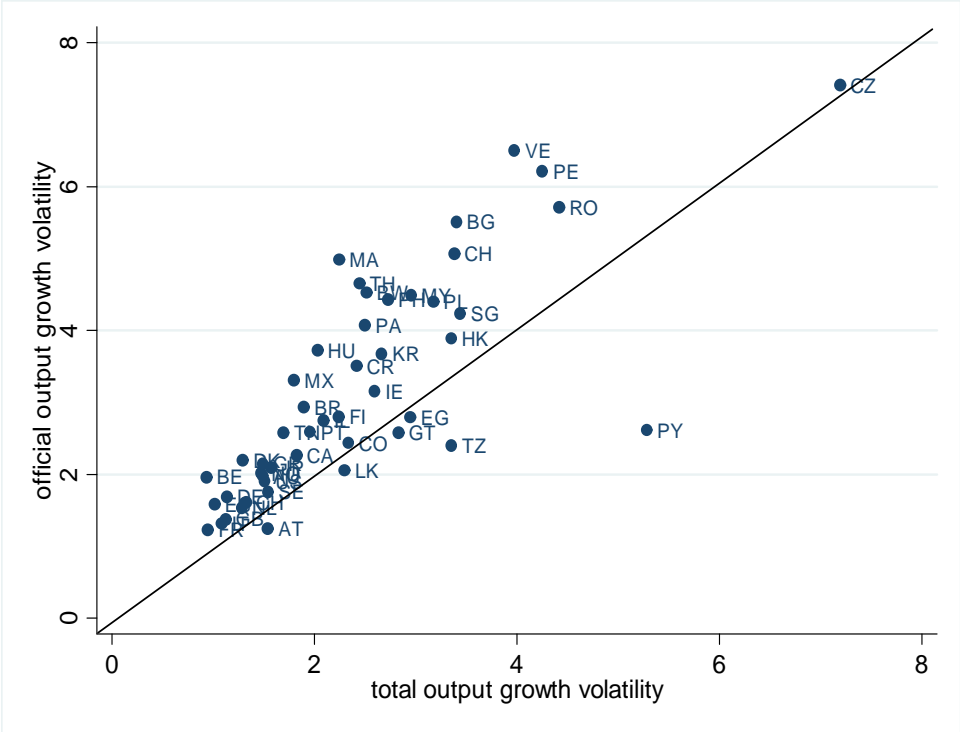
Note: Slovakia is an outlier and excluded from the graph.

Figure 6- Output growth volatility and output growth- 1981-2005
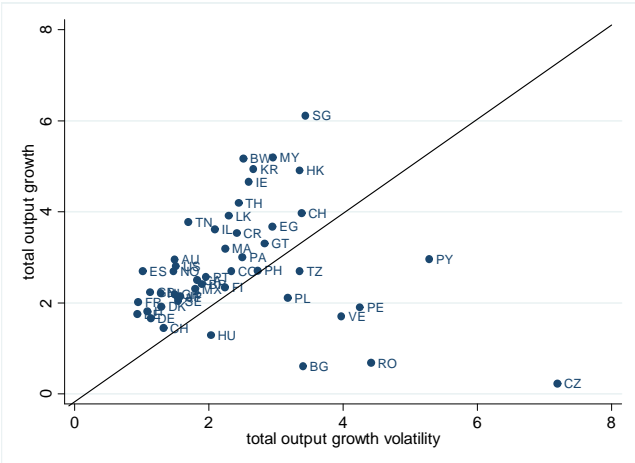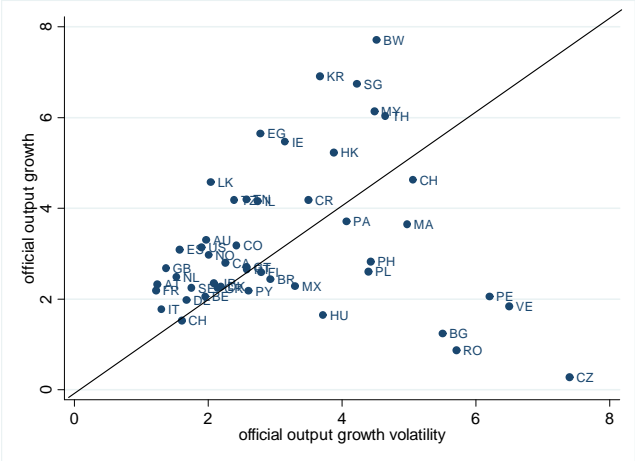
Note: Slovakia is an outlier and excluded from the graph.

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5   Appendix I- Econometric Methodology

5.1   Panel stationary tests

The stationarity of the variables $\Delta Elec$, $\Delta Eprice$ and $\Delta IndGdp$ has been initially tested adopting the Im, Pesaran and Shin (IPS) methodology for the null of unit root in heterogeneous panels. This test is based on the hypothesis that the error terms are independent across cross-sections and may suffer from size distortions in the presence of cross-sectional dependence (Im, Pesaran and Shin, 2003). Therefore, to support the result of the IPS test, we performed the Pesaran (PES) test for unit roots in heterogeneous panels with cross-sectional dependence (Pesaran, 2003, 2007). [18] Since these two tests reject the null of unit root even if only one series is stationary, we also performed the Hadri test for the null of stationarity in heterogeneous panels. This test rejects the null of stationarity even if only one series is not stationary and it is based on the assumption of cross-sectional independence of the error terms (Hadri, 2000). [19] Thus, to support the results of the Hadri test, we have finally performed separate Kwiatkowski, Phillips, Schmidt and Shin (1992) (KPSS), ADF and Phillips-Perron (PP) unit root tests.

Table 4 reports the results of the IPS and Pesaran tests. The null of unit root for all variables is rejected against the alternative hypothesis that at least one series is stationary.

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[18] We have performed a truncated version of the CADF statistics which has finite first and second order moments. Pesaran (2003) suggests replacing extreme values of the test statistics by K1 or K2 such that Pr [-K1 < t_i (N,T) < K2] is sufficiently large, namely in excess of 0.9999. As noted by Pesaran, this truncated test statistic allows to avoid size distortions, especially in the case of models with residual serial correlations and linear trends.

[19] Giulietti, Otero and Smith (2006) demonstrate that the Hadri test may suffer from size distortions in the presence of cross-sectional dependence when N=50 and T=25. However, also their alternative Bootstrap Hadri Test may suffer from size distortions in the presence of cross-sectional dependence when N=50 and T=25.

Table 4- Panel unit root test

H_0: all 49 timeseries in the panel are non-stationary processes; H_1: at least one series is stationary

τ =individual linear trends

	IPS	**PES**	**IPS**(τ)	**PES**(τ)
ΔEC	$-14.6*$	$-11.9*$	$-13*$	$-10.3*$
ΔPE	$-12.3*$	$-9.2*$	$-13.9*$	$-5.2*$
ΔI	$-15.7*$	$-12.5*$	$-11.9*$	$-9.4*$

Note: The statistics are asymptotically distributed as a standard normal with a left hand side rejection area. A * indicates the rejection of the null hypothesis of nonstationarity at least at the 5 percent level of significance.

The results of the Hadry test are reported in Table 5. The statistics indicate that there is evidence of non stationarity for all variables $\Delta Elec$, $\Delta Eprice$ and $\Delta IndGdp$.

Table 5- Hadri panel stationary test

H_0: all 49 timeseries in the panel are stationary processes; H_1: at least one series is not stationary

$Homo$: homoskedastic errors across countries; $Hetero$: heteroskedastic errors across countries; $SerDep$: serial dependence in the errors

τ =individual linear trends

		$Z(\mu)$	$Z(\tau)$
ΔEC	$Homo$	$1.9*$	0.4
ΔEC	$Hetero$	$4.8*$	$4.6*$
ΔEC	$SerDep$	$5.5*$	$18.8*$
ΔPE	$Homo$	$14.8*$	-3
ΔPE	$Hetero$	$10.4*$	$2.9*$
ΔPE	$SerDep$	$8.9*$	$21.3*$
ΔI	$Homo$	-1.3	$2.8*$
ΔI	$Hetero$	0.9	$3*$
ΔI	$SerDep$	$2.7*$	$17.3*$

Note: The statistics are asymptotically distributed as a standard normal with a right hand side rejection area. A * indicates the rejection of the null hypothesis of stationarity at least at the 5 percent level of significance.

Finally, according to the separate KPSS, ADF and PP unit root tests, a significant portion of series of each relevant variable have a unit root.

The differenced series $\Delta\Delta Elec$, $\Delta\Delta Eprice$ and $\Delta\Delta IndGdp$ are stationary.

5.2   Cointegration statistics

With non-stationary pooled time series, the application of the OLS estimator may result in biased and inconsistent estimates (Granger and Newbold, 1974; Engle and Granger, 1987). To define an appropriate estimator for equation (1), it has been therefore necessary to turn to panel cointegration techniques. The presence of cointegrating relationships between $\Delta Elec$, $\Delta Eprice$ and $\Delta IndGdp$ has been tested using the residual-based procedure developed by Pedroni (1999, 2004). [20] The Pedroni group tests have a null of no cointegration for all countries of the panel against the alternative hypothesis of cointegration for at least one country. Table 6 reports the results. All Pedroni group-statistics reject the null of no cointegration. These tests are based on the assumption of errors cross-sectional independence. As noted by Pedroni (2004), common time dummies can be included in the regression equation in order to eliminate some forms of cross-sectional dependence. [21] As Table 6 shows, including time dummies our results are confirmed. The null of no cointegration is rejected by all group statistics.

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[20] Pedroni (2004) uses these cointegration tests for testing the purchasing power parity for the post-Bretton Woods period. In particular, he uses a panel of 25 countries for the period June 1973-December 1994 and reports the results for both annual, T=20, and monthly, T=246, data.

[21] As noted by Pedroni (2004), for many cases this approach may be appropriate, as, for example, when common business cycle shocks impact the data for all individuals of the panel together. In other cases, additional cross-sectional dependencies may exist in the form of relatively persistent dynamic feedback effects that run from one country to another and that are not common across countries, in which case common time effects will not account for all the dependency. If the time series dimension is long enough relative to the cross-sectional dimension, the one practical solution in such cases may be to employ a GLS approach based on the estimation of the panel-wide asymptotic covariance for the weighting matrix. Most recently, Gengenbach, Palm and Urbain (2006) propose a common factor structure to model the cross-sectional dependence for panel no-cointegration tests. Moreover, a bootstrap test for the null hypothesis of cointegration in panel data is presented by Westerlund and Edgerton (2007).

Table 6- Pedroni residual-based cointegration test

H_0: no cointegration for all countries; H_1: for at least one country there is cointegration;

Group statistics	No time dummies	Time dummies
$Rho - statistic$	$-10.8*$	$-10.5*$
$PP - statistic$	$-24*$	$-24.3*$
$ADF - statistic$	$-17.8*$	$-19.5*$

Note: All reported values are asymptotically distributed as a standard normal. The Pedroni tests are left-sided. A * indicates the rejection of the null hypothesis of no cointegration at least at the 5 per cent level of significance.

The Pedroni cointegration test statistics may suffer from size distortions when the time dimension of the panel is not significantly large with respect to the cross sectional dimension (Pedroni, 2004). Therefore, the same cointegration analysis has been applied to seven subgroups of the panel with T>N. [22] These additional tests confirm the initial results. The null of no cointegration is always rejected. However, the test of Pedroni rejects the null of no cointegration even if the residuals of a pooled OLS estimation of equation (1) are stationary only for one country. Therefore, to determine whether the residuals of each of the 49 cross-sections of equation (1) are stationary we have performed separate ADF, Phillips-Perron and KPSS unit root tests. These values demonstrate that the OLS residuals are stationary for a significant portion of countries. In particular, there is evidence of non-stationarity in the residuals only for two countries, Canada and Hungary.

Due to the presence of cointegrated time series, for the estimation of equation (1) we have used the group-mean panel Fully Modified Ordinary Least Squares (FMOLS) method proposed by Pedroni (2000, 2001). The group-mean FMOLS estimator allows for the heterogeneity of the panel and adjusts for the effects of autocorrelation of the errors. This estimator also adjusts for the potential long-run endogeneity of the regressors.

In order to eliminate some forms of cross-sectional dependence, we have also included in the regression common time dummies (Pedroni, 2000, 2001). Table 7 reports the estimation results. The group-FMOLS estimates suggest that - considering the entire panel of 49 countries- a positive

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[22] We have tested the presence of cointegration in 20 highly industrialized OECD countries, 16 European countries, 6 Transition countries, and 23 non OECD countries countries: 10 Latin American countries, 5 African countries, and 8 Asian countries.

and statistically significant relationship exists between the changes in electric consumption and those in the share of industry. On the contrary, a negative and statistically significant relationship exists between the changes in electric consumption and those in electricity price. [23]

As noted by Pedroni (2000), the group-mean FMOLS estimator may suffer from size distortions when N is large relative to T. [24] Thus, we have estimated the same regression equation considering four subgroups of countries with T large relative to N. [25] As Table 7 shows, including or not common time dummies, these results are close to those obtained examining the entire panel of countries. Only for the non OECD economies, the relationship between the changes in electric consumption and those in electricity price becomes positive and non-statistically significant in the presence of time dummies[26].

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[23]To use changes in country-specific electricity price as an explanatory variable for changes in electricity consumption may generate problems of endogeneity. Firstly, we have re-estimated equation (1) adopting an alternative more exogenous real price of energy for 26 OECD countries and a global index of energy price for the remaining 23 countries (see Appendix II for a description of the data). Second, we have used the global price of energy for the entire panel. In both situations we have obtained the same result. There is a positive and statistically significant relationship between changes in electricity consumption and changes in industry share of GDP. There is a negative and statistically significant relationship between changes in electricity usage and changes in the price of energy.

[24]Using Monte Carlo simulations, Pedroni (2000) demonstrates that, in the bivariate case, the small sample distortion of the group-mean fully modified OLS estimator tends to be high when N > T, and decreases as T > N. This is a practical consequence of any fixed effects model.

[25]We have employed the FMOLS estimation for 20 highly industrialized OECD countries, 16 European countries, 22 European countries (including 6 Transition countries), and 23 non OECD countries (African, Asian and Latin American countries).

[26]The residual changes in electricity consumption are therefore stationary. To prove that also the dynamics of unrecorded income follow a stationary process, we have tested the stationarity of the annual changes in official GDP, ΔGdp. We have found a strong evidence of stationarity.

Table 7- FMOLS estimation

<u>TD = Time dummies</u>

Dep Var ΔEC	ΔI	ΔPE	ΔI (TD)	ΔPE (TD)
$Entire panel$	0.88*	−0.09*	0.84*	−0.02*
$OECD$	0.70*	−0.10*	0.76*	−0.05*
$European$	0.78*	−0.10*	0.79*	−0.06*
$European*$	0.83*	−0.10*	0.80*	−0.08*
$NonOECD$	1.03*	−0.08*	0.79*	0.07

Note: t-stats (not reported) are for $H_0 : \beta_i = 0$ for all i vs $H_1 : \beta_i \neq 0$ for all i. A * indicates the rejection of the null hypothesis of stationarity at least at the 5 percent level of significance.

$European*$ indicate European countries including Transition economies; $NonOECD$ indicate non OECD countries excluding Transition economies.

In the paper, we present results based on country-specific FMOLS estimators for equation (1).[27]

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[27] We have also computed residual electricity consumption series using both the full panel FMOLS coefficients and separate subpanel coefficients (highly industrialized OECD non European, European, and Developing countries) reported in Table 7. The three series computed for electricity usage are quite similar (results available upon request).

6   Appendix II- description of data

6.1   Panel analysis

Total Electricity Consumption (kWh). *Source: Energy Information Administration (EIA).* This variable is obtained as the Net Total Electricity Generation *plus* Electricity Imports *minus* Electricity Exports *minus* Electricity Distribution Losses. We used this variable for 46 countries.

Total Final Electricity Consumption (ktoe). *Source: International Energy Agency (IEA).* This variable reflects the sum of the electricity consumption in the end-use sectors. Electricity used for transformation and for own use of the energy producing industries is excluded. Due to the lack of complete information, we used this variable- instead of Total Electricity Consumption (source: *EIA*)- for Germany, Czech Republic and Slovakia. Data for pre-unification Germany include electricity consumption in the Democratic Republic of Germany.

Index of Electricity End-Use Prices. *Source: International Energy Agency (IEA).* To calculate this real price index, the nominal prices were deflated with country-specific producer price indices for the industry sector and with country-specific consumer price indices for the household sector. We used this country-specific index for 26 OECD countries.

OECD Index of Electricity End-Use Prices. *Source: International Energy Agency (IEA).* This variable is the aggregate Index of Electricity End-Use Prices for 26 OECD countries.

World Index of Energy Prices. *Source: World Bank (WB), Commodity Price Data.* For 23 countries- for which country-specific data on electricity prices were not available- the relative electricity prices were proxied by this global index of real energy price.

Industrial Income. *Source: United Nations Statistics Division (UNSD).* Constant (1990) prices- US Dollars.

Official GDP. *Source: United Nations Statistics Division (UNSD).* Constant (1990) prices- US Dollars.

Agricultural Income. *Source: United Nations Statistics Division (UNSD).* Constant (1990) prices- US Dollars.

Self-employment. *Source: International Labour Organization (ILO).*

6.2 Cross-section analysis (Table 3)

Index of Business Freedom (IBF). *Source: Heritage Foundation.* Business freedom is a quantitative measure of the ability to start, operate, and close a business that represents the overall burden of regulation, as well as the efficiency of government in the regulatory process. The business freedom score for each country is a number between 0 and 100, with 100 equaling the freest business environment. The score is based on 10 factors, all weighted equally, using data from the World Bank's *Doing Business* study:

- Starting a business- procedures (number);

- Starting a business- time (days);

- Starting a business- cost (% of income per capita);

- Starting a business- minimum capital (% of income per capita);

- Obtaining a license- procedures (number);

- Obtaining a license- time (days);

- Obtaining a license- cost (% of income per capita);

- Closing a business- time (days);

- Closing a business- cost (% of estate);

- Closing a business- recovery rate (cents on the dollar).

  Each of these raw factors is converted to a scale of 0 to 100, after which the average of the converted values is computed. The result represents the country's business freedom score. Each factor is converted to a 0 to 100 scale using the following equation:

$$Factor\ Score_i = 50 \times \text{factor}_{average} \,/\, \text{factor}_i$$

which is based on the ratio of the country data for each factor relative to the world average, multiplied by 50.

In the paper we used the average values of *IBF* for the period 1997-2001.

Index of Trade Freedom (ITF). *Source: Heritage Foundation.* Trade freedom is a composite measure of the absence of tariff and non-tariff barriers that affect imports and exports of goods and services. The trade freedom score is based on two inputs:

- The trade-weighted average tariff rate

- Non-tariff barriers (NTBs).

The weighted average tariff uses weights for each tariff based on the share of imports for each good. Weighted average tariffs are a purely quantitative measure and account for the basic calculation of the score using the following equation:

$$TradeFreedom_i = (((Tariff_{\max} - Tariff_i)/(Tariff_{\max} - Tariff_{\min})) * 100) - NTB_i$$

where $Trade\ Freedom_i$ represents the trade freedom in country i, $Tariff_{\max}$ and $Tariff_{\min}$ represent the upper and lower bounds for tariff rates (%), and $Tariff_i$ represents the weighted average tariff rate (%) in country i. The minimum tariff is naturally zero percent, and the upper bound was set as 50 percent. An NTB penalty is then subtracted from the base score. The penalty of 5, 10, 15, or 20 points is assigned according to the following scale:

- 20—NTBs are used extensively across many goods and services and/or act to effectively impede a significant amount of international trade;

- 15—NTBs are widespread across many goods and services and/or act to impede a majority of potential international trade;

- 10—NTBs are used to protect certain goods and services and impede some international trade;

- 5—NTBs are uncommon, protecting few goods and services, and/or have very limited impact on international trade;

- 0—NTBs are not used to limit international trade;

The extent of NTBs in a country's trade policy regime is determined using both qualitative and quantitative information. Restrictive rules that hinder trade vary widely, and their overlapping and shifting nature makes their complexity difficult to gauge. The categories of NTBs considered in our penalty include:

- Quantity restrictions—import quotas; export limitations; voluntary export restraints; import–export embargoes and bans; countertrade, etc.

- Price restrictions—antidumping duties; countervailing duties; border tax adjustments; variable levies/tariff rate quotas.

- Regulatory restrictions—licensing; domestic content and mixing requirements; sanitary and phytosanitary standards (SPSs); safety and industrial standards regulations; packaging, labeling, and trademark regulations; advertising and media regulations.

- Investment restrictions—exchange and other financial controls.

- Customs restrictions—advance deposit requirements; customs valuation procedures; customs classification procedures; customs clearance procedures.

- Direct government intervention—subsidies and other aid; government industrial policy and regional development measures; government-financed research and other technology policies; national taxes and social insurance; competition policies; immigration policies; government procurement policies; state trading, government monopolies, and exclusive franchises.

  In the paper we used the average values of *ITF* for the period 1997-2001.

Stability (STABS). *Source: Database of Political Institutions (DPI)*. This counts the percent of veto players who drop from the government in any given year. Veto players are defined as follows: for presidential systems, the veto players are the president, the largest party in the legislature, and the largest party in the Senate; for parliamentary systems, veto players are defined as the prime minister and the three biggest coalition members. In the paper we used the values of *stabs* for 2000.

Executive Indices of Electoral Competitiveness (IEC). *Source: Database of Political Institutions (DPI)*. For executives who are:

- elected directly by population, or

- elected by an electoral college that is elected by the people and has the sole purpose of electing the executive,

  the same scale as Legislative Index of Electoral Competitiveness (source: *DPI*) is used:

- No executives = 1

- Unelected executive = 2

- Elected, 1 candidate = 3

- 1 party, multiple candidates = 4

- Multiple parties are legal but only one party won seats = 5

- Multiple parties won seats but the largest party received more than 75% of the seats = 6

- Largest party got less than 75% = 7

In the paper we used the values of *IEC* for 2000.

Number of procedures required to enforce a contract (log PROC). *Source: World Bank (WB), Doing Business Database.* We used the only available data for the period 2004-2005.

Level of education (EDU). *Source: Unesco.* The school life expectancy (primary to tertiary education) is defined as the total number of years of schooling which a child can expect to receive, assuming that the probability of his or her being enrolled in school at any particular future age is equal to the current enrolment ratio at that age. It is a synthetic summary indicator of the overall pattern of enrolment ratios at one particular point in time, and has no predictive value except in so far as it is believed that enrolment patterns will remain unchanged into the future.

In the paper we used the values of *education* for 2000.

7   Appendix III- Graphical Analysis

Figure 7- Changes in electricity consumption raw *versus* filtered series

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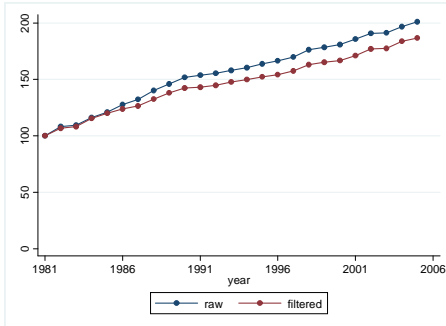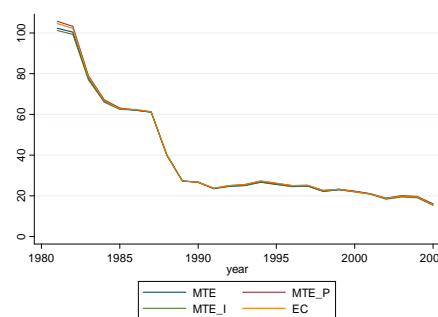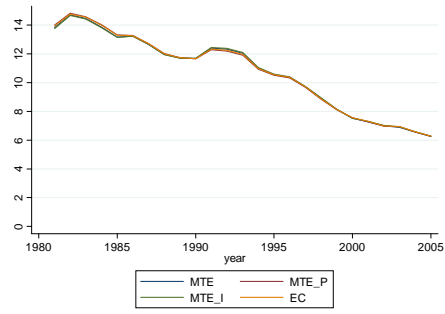

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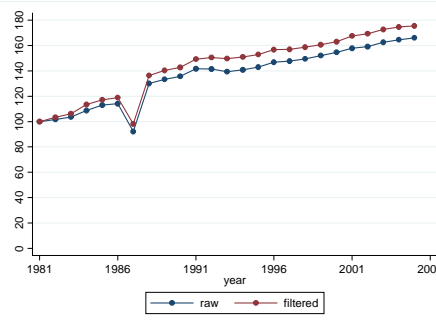
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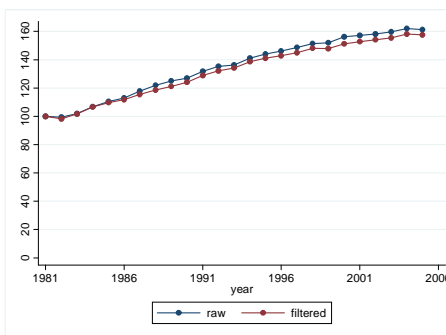
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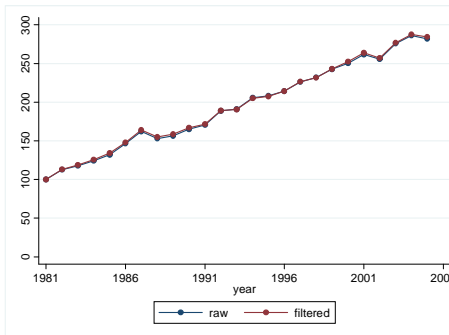
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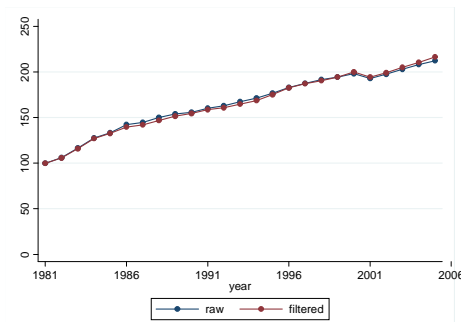
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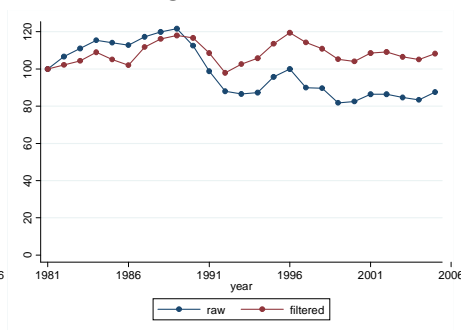
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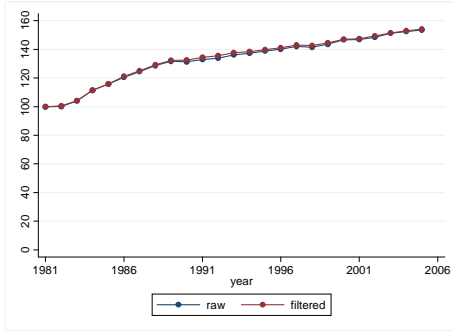
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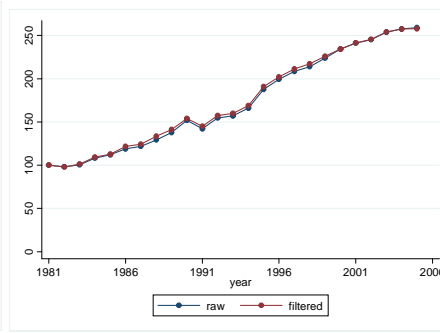
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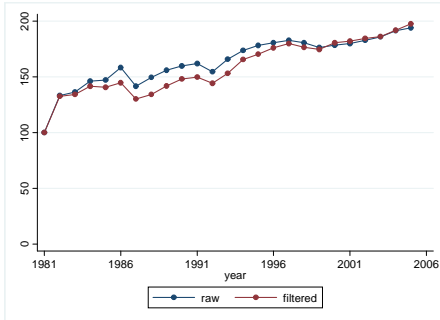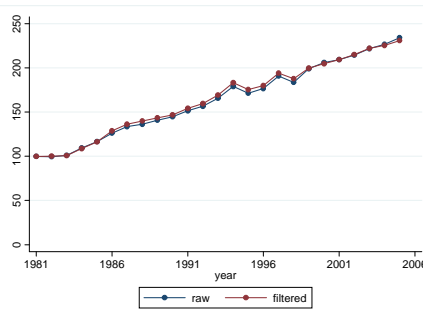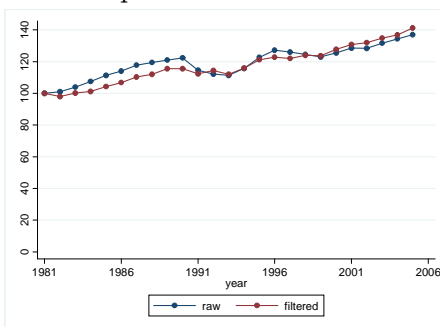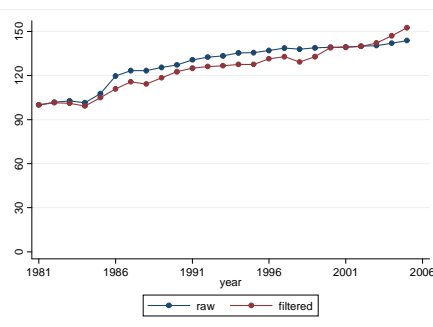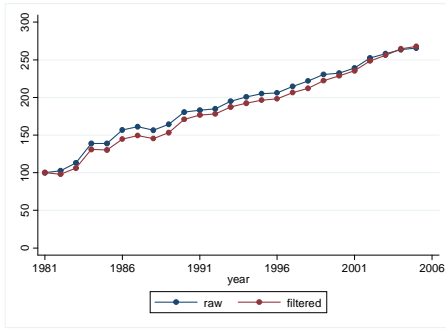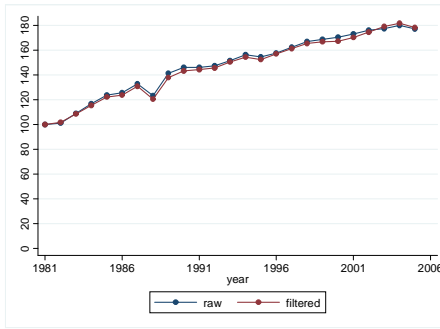
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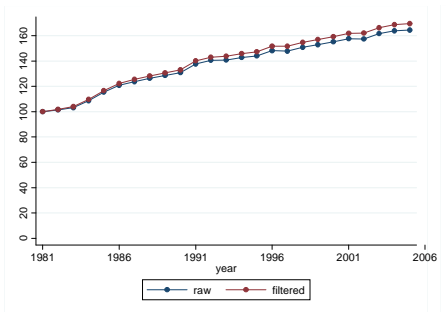
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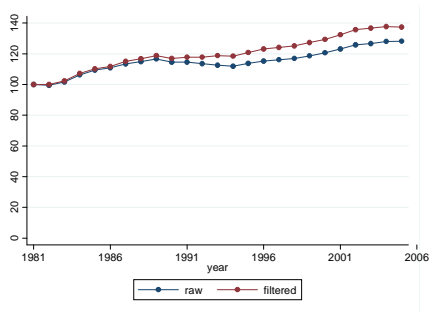
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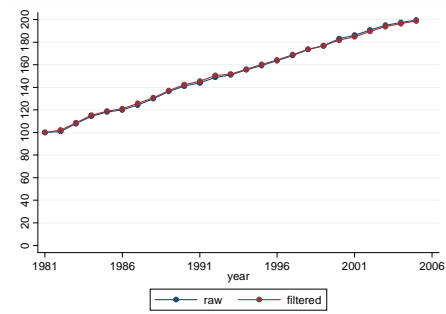
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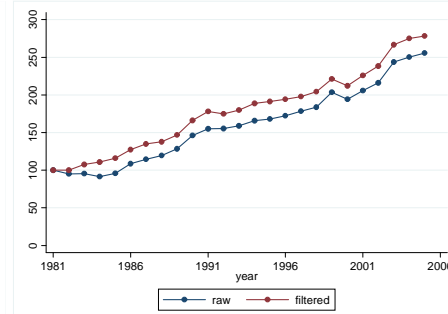
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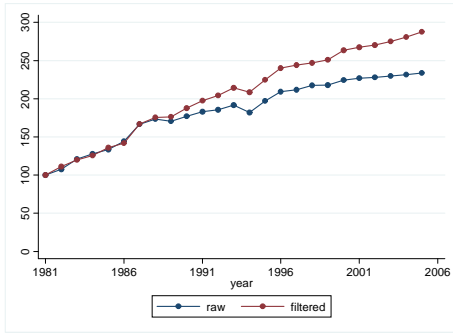
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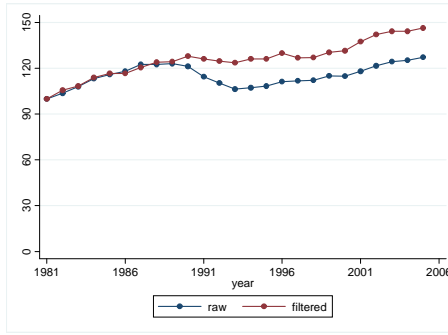
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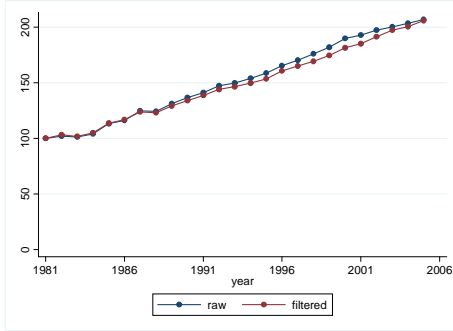
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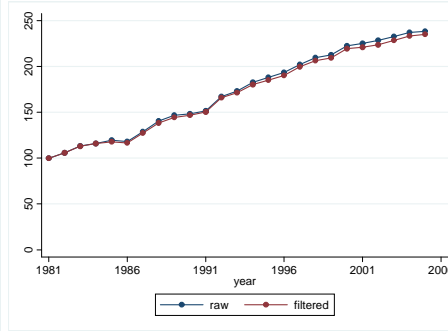
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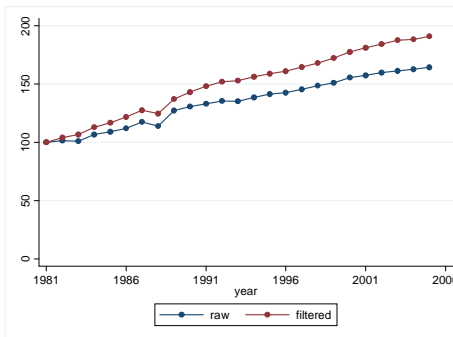
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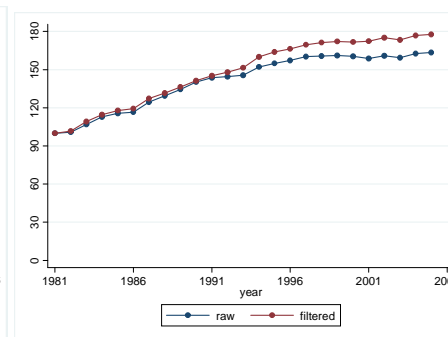
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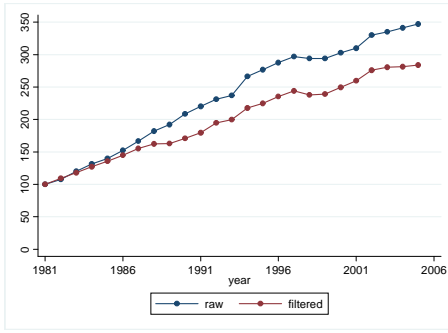
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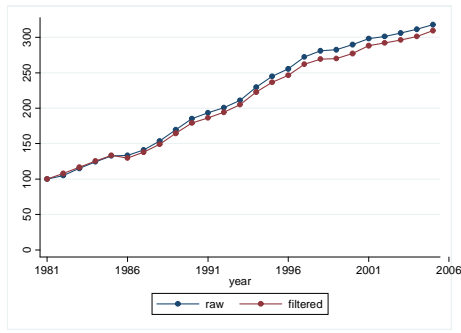
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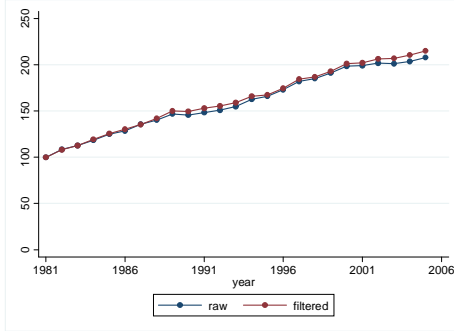
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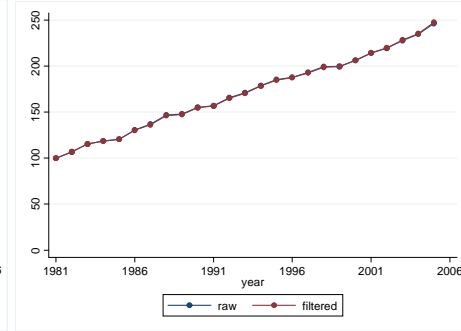
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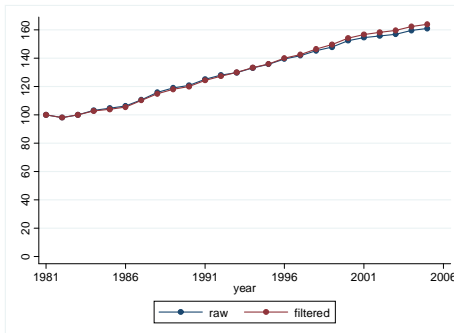
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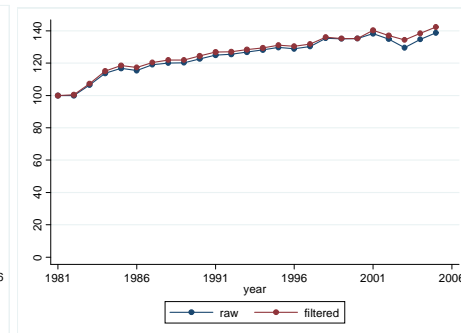
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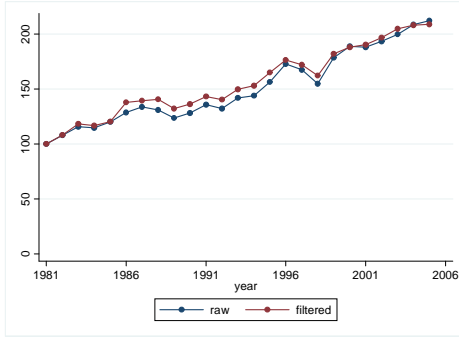
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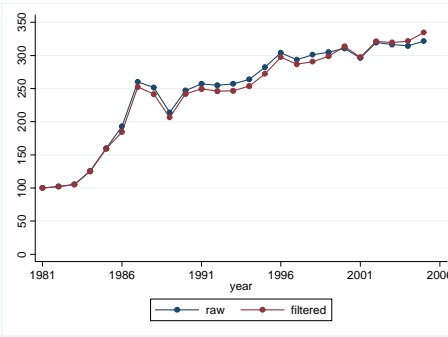
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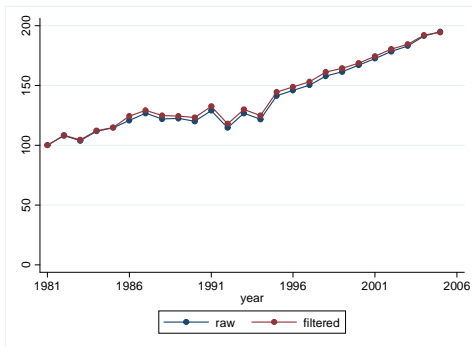
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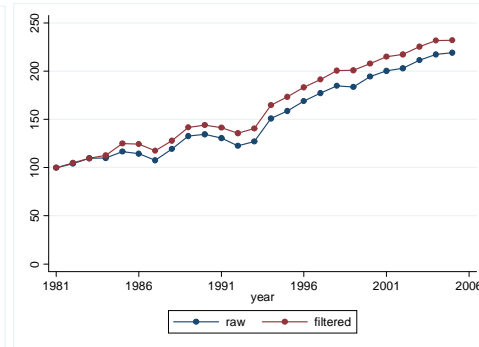
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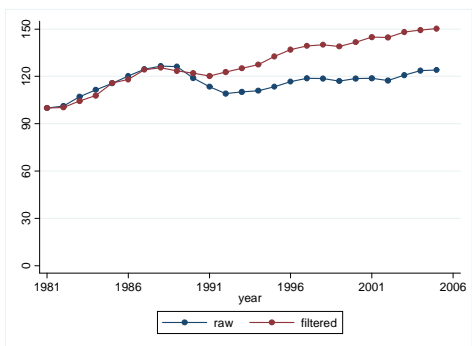
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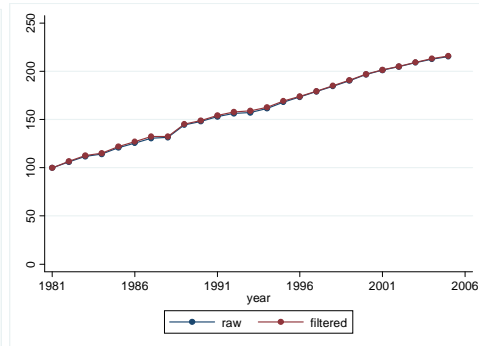
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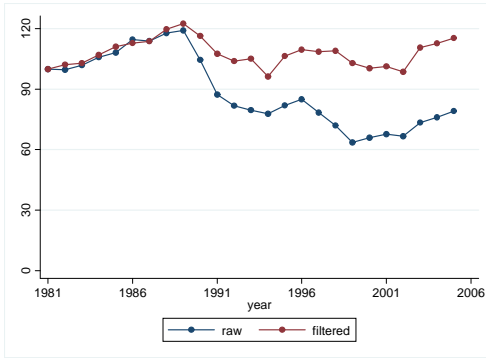
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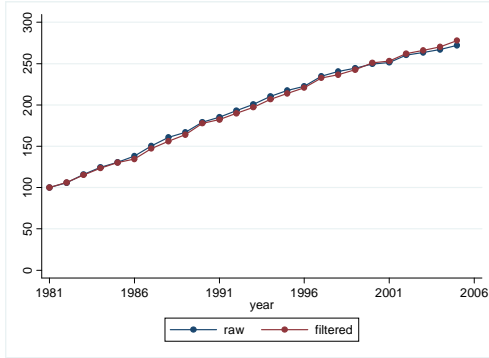
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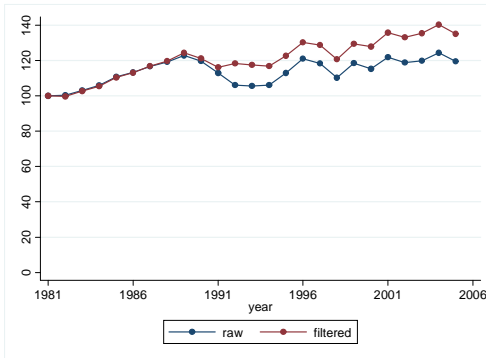
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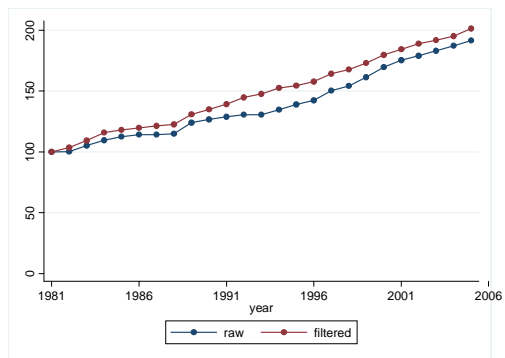
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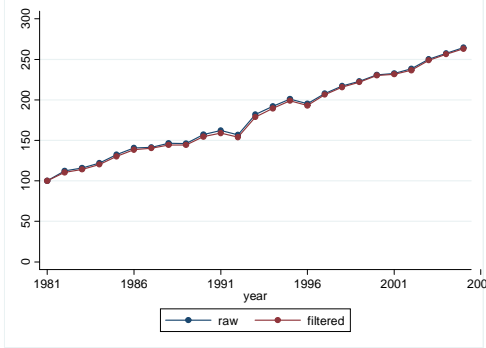
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United States

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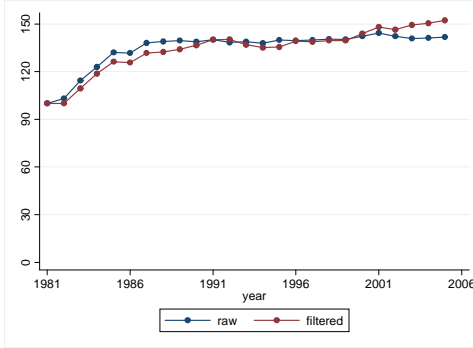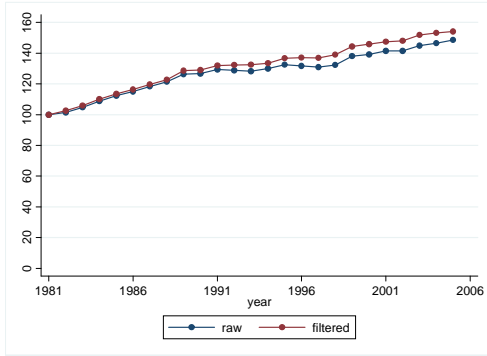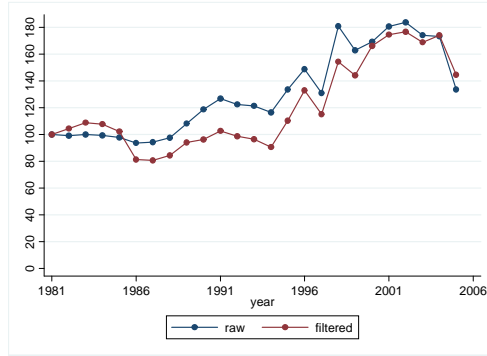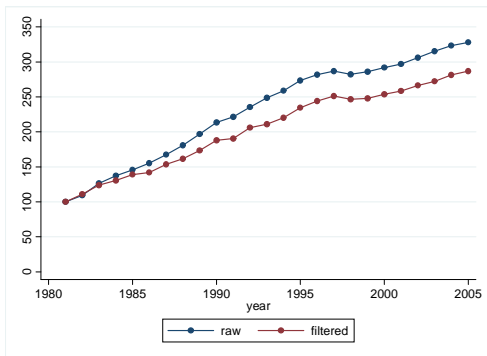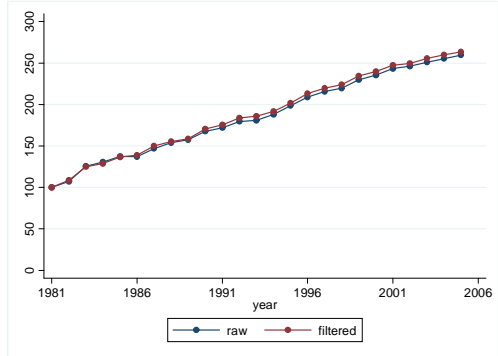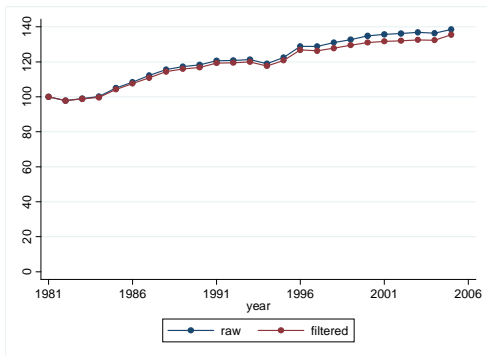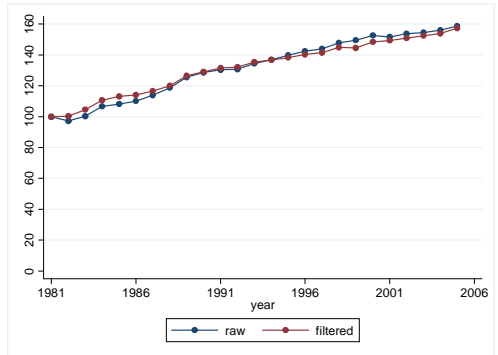
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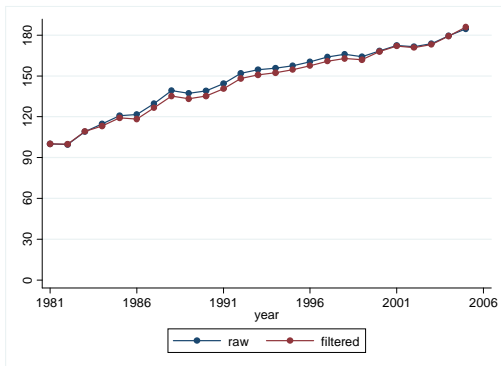
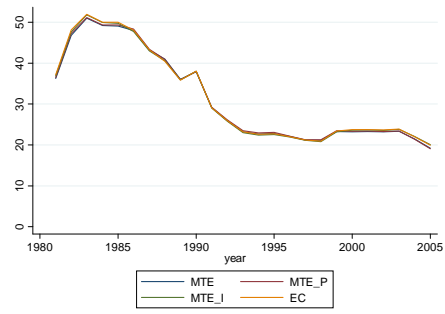**Figure 8- MTE *versus* ECM estimates (% official GDP)**
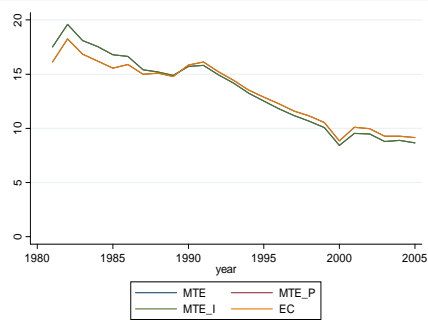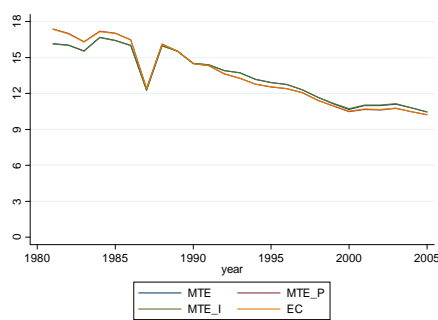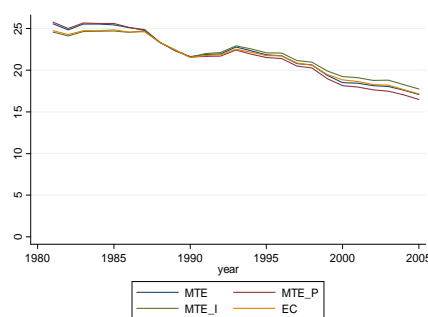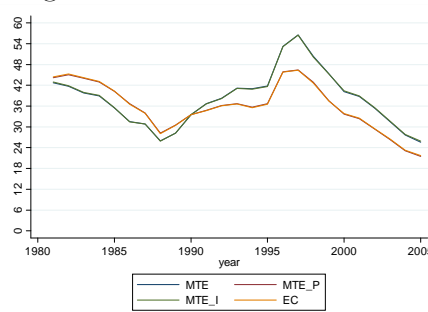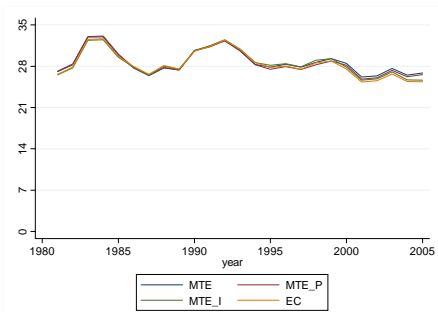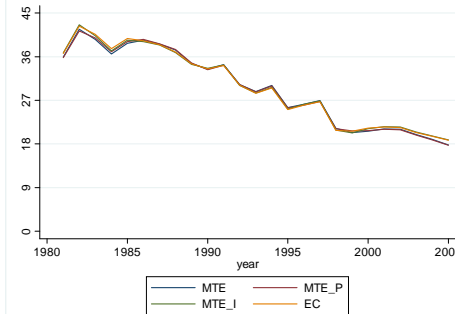
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Botswana

Bulgaria

Brazil

Canada

Chile

Colombia

Costa Rica

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Greece

Guatemala

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Poland

Portugal

Romania

Singapore

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Spain

Sri Lanka

Sweden

Switzerland

Tanzania

Thailand

Tunisia

United Kingdom

United States

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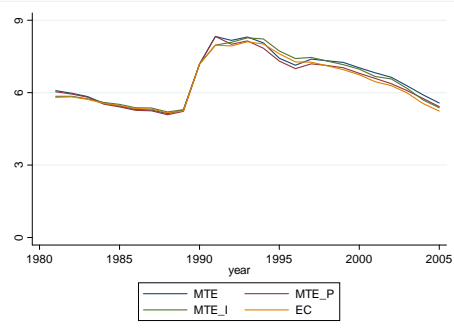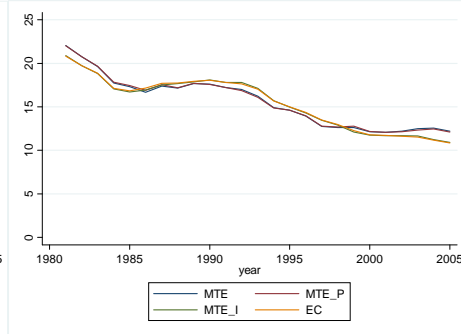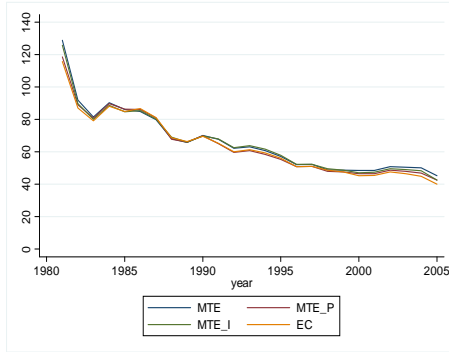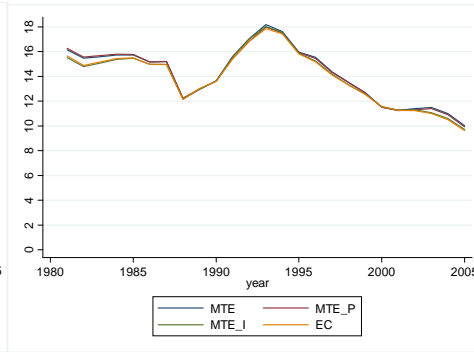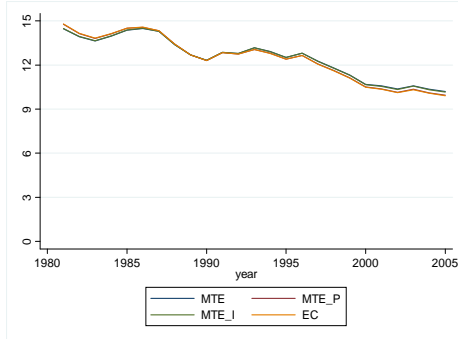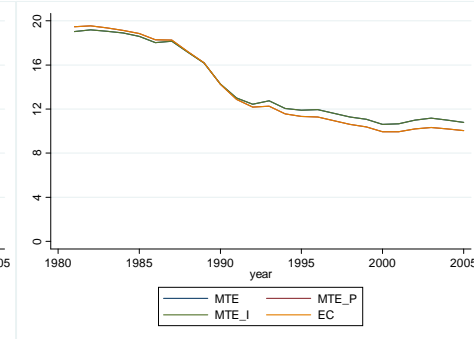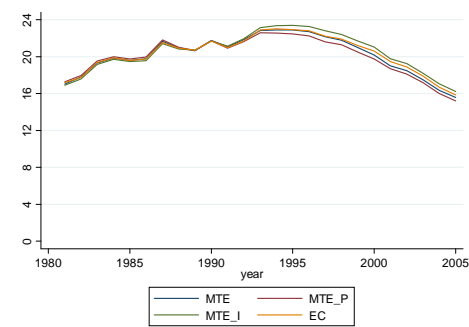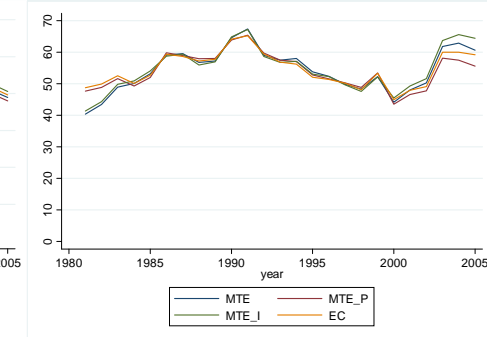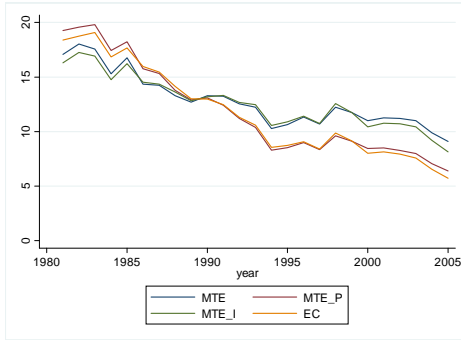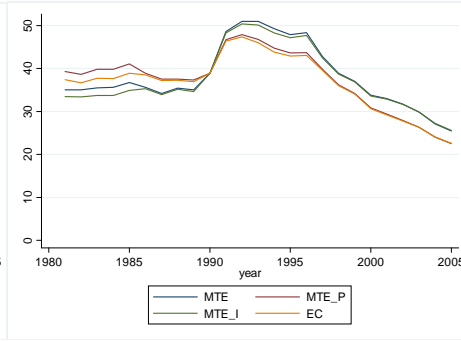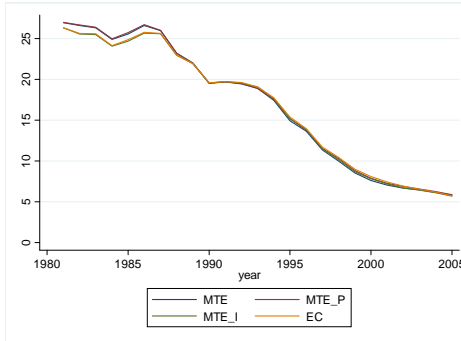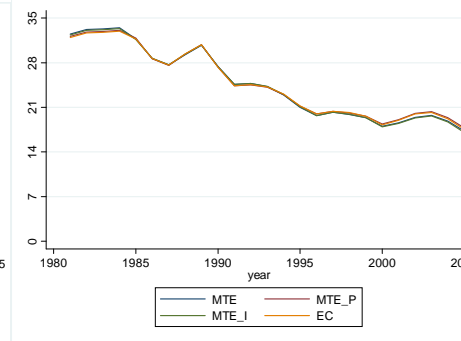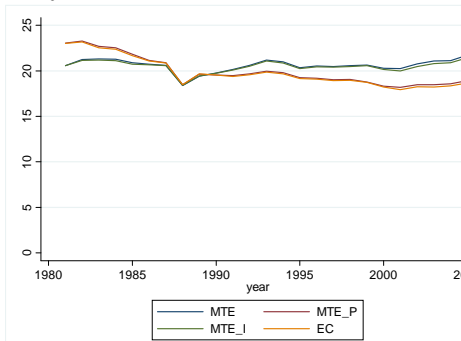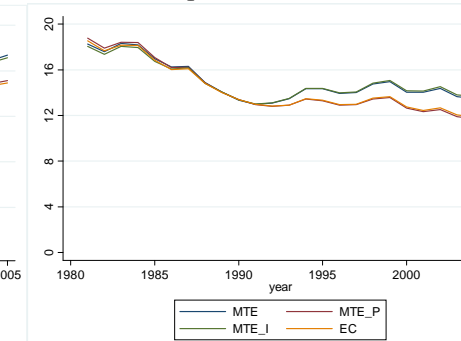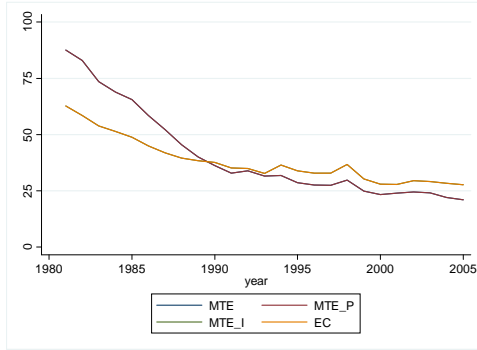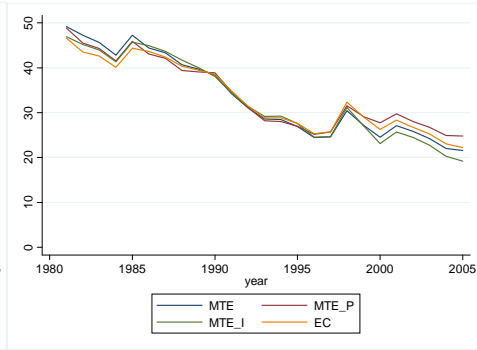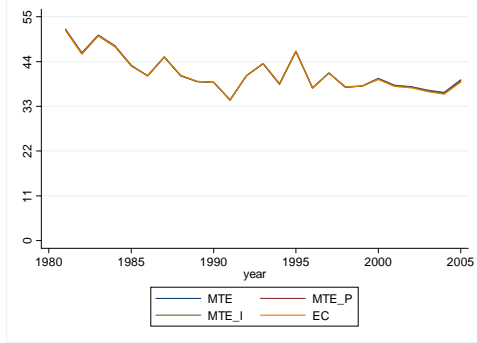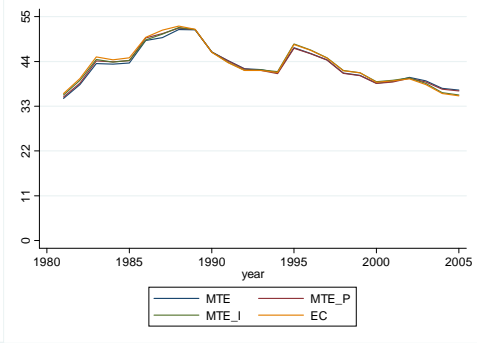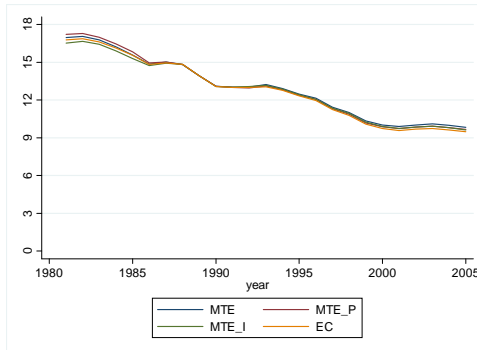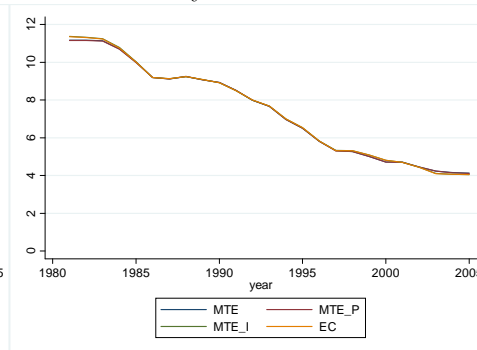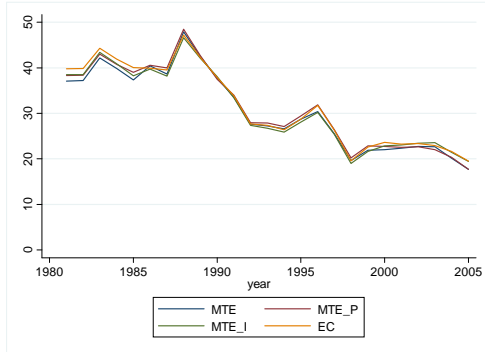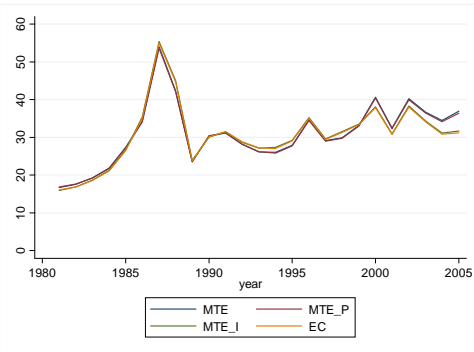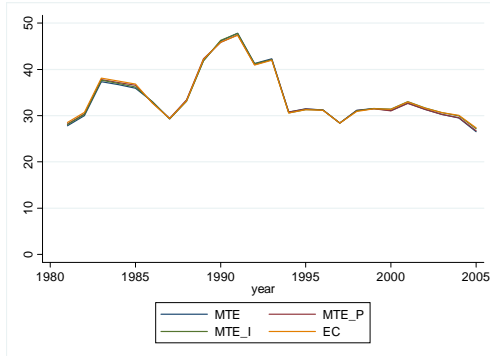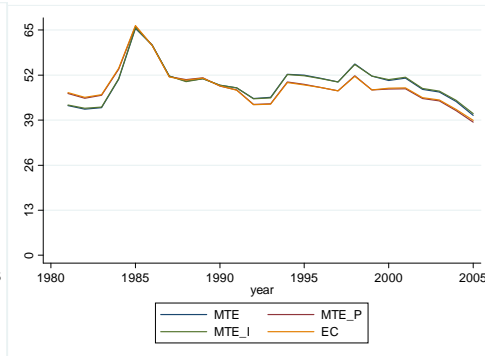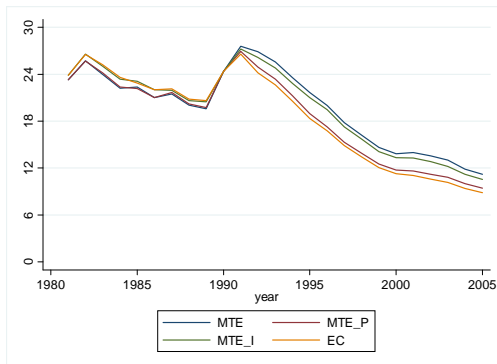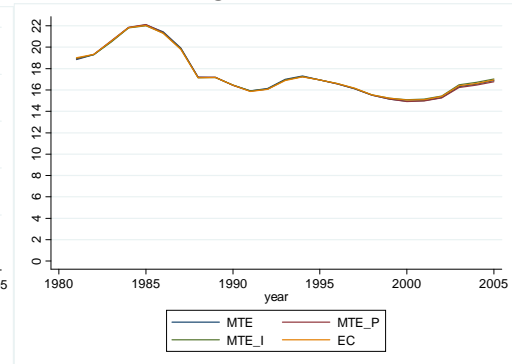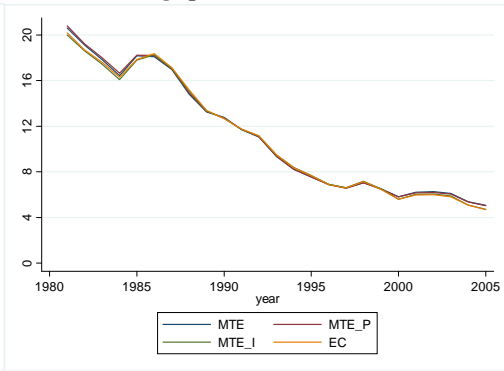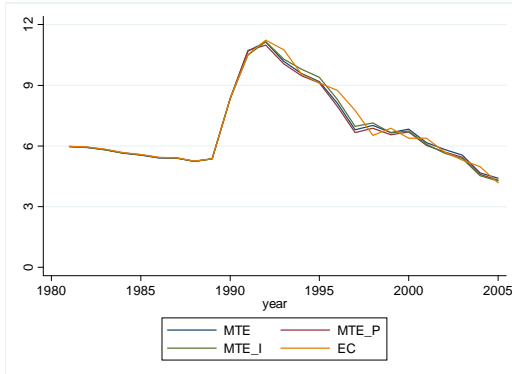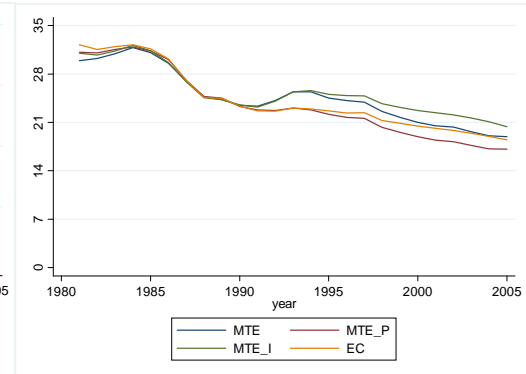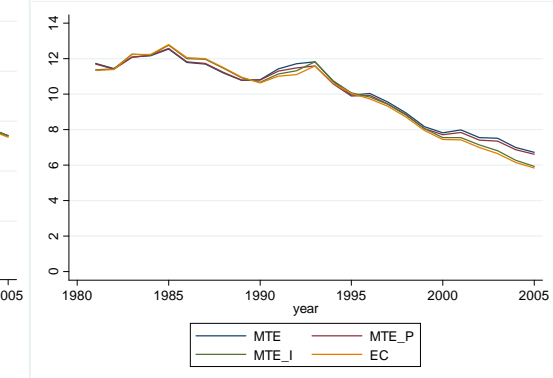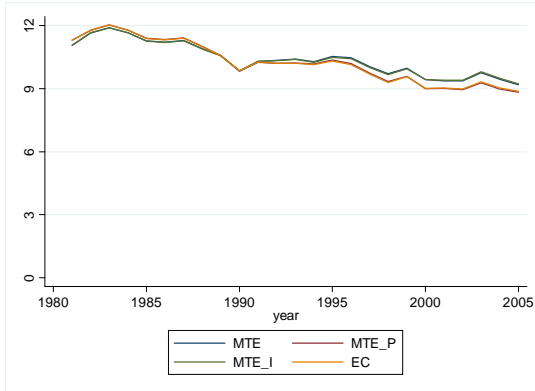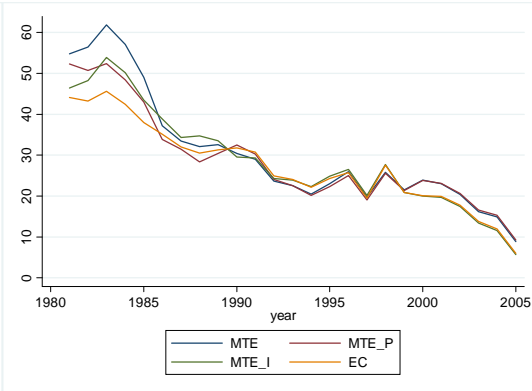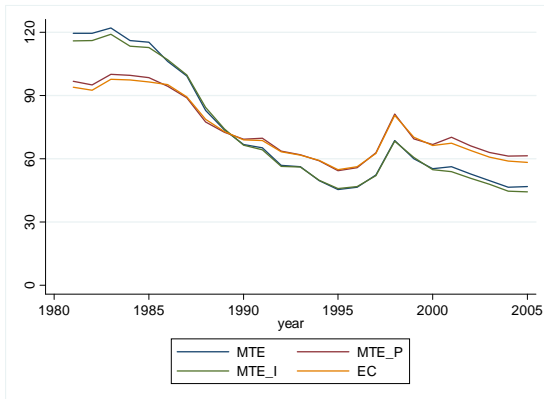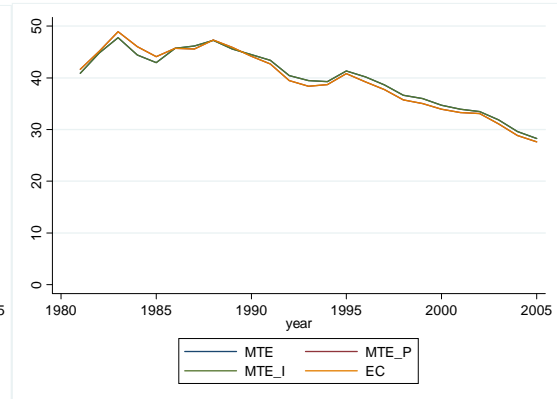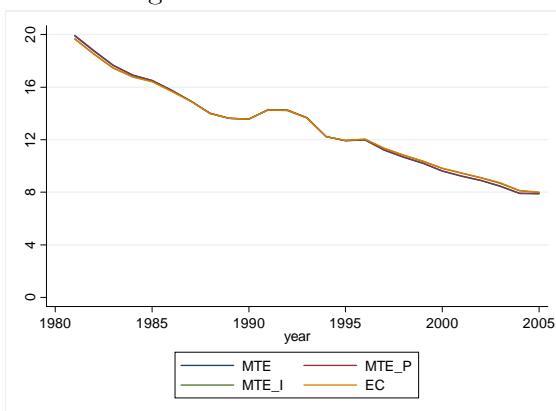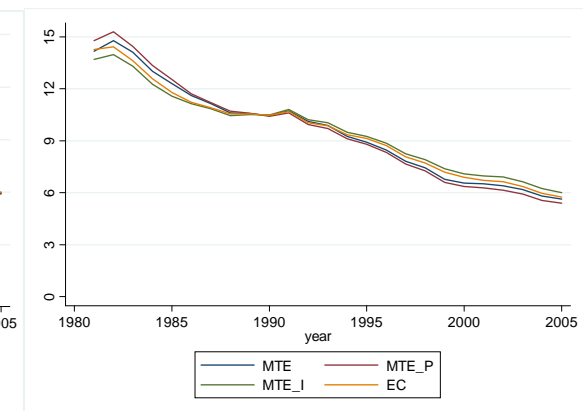
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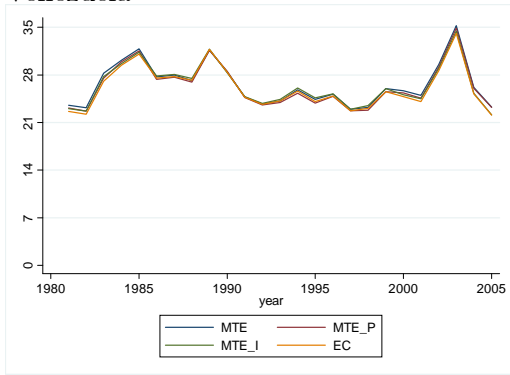
Source: own calculations

Figure 9- MTE, MIMIC and Chong and Gradstein's estimates (% official GDP)
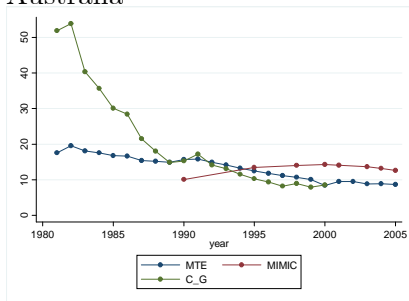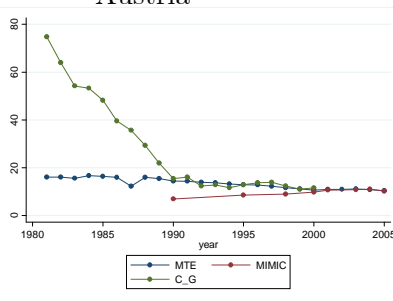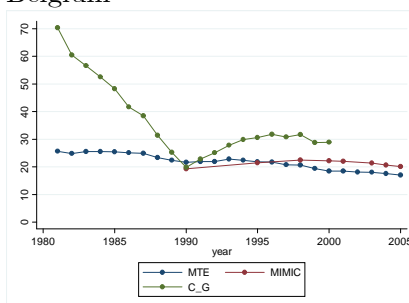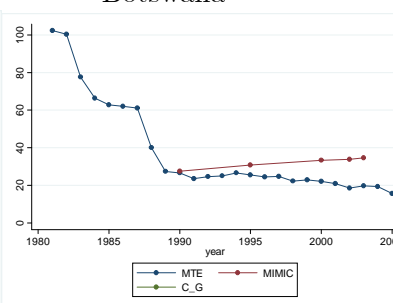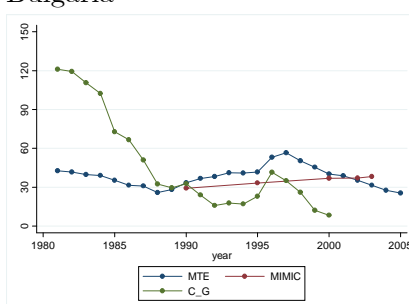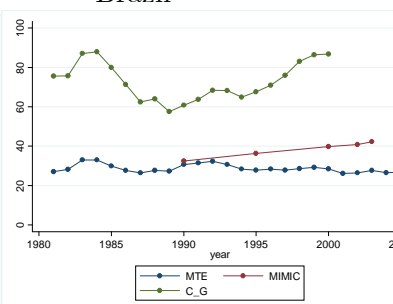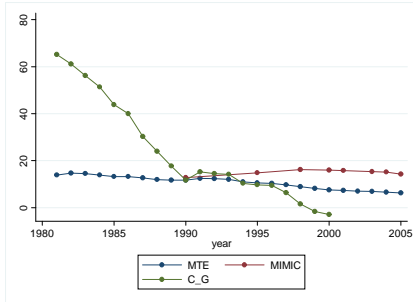
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Austria

Belgium

Botswana

Bulgaria

Brazil

Canada

Chile

Colombia

Costa Rica

Czech Republic

Denmark

Egypt

Finland

France

Germany

Greece

Guatemala
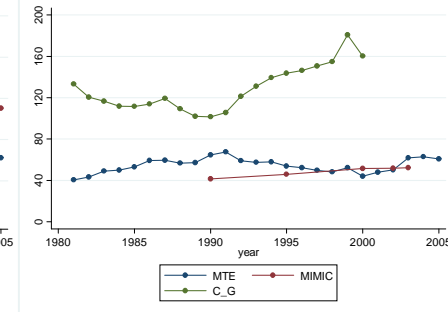
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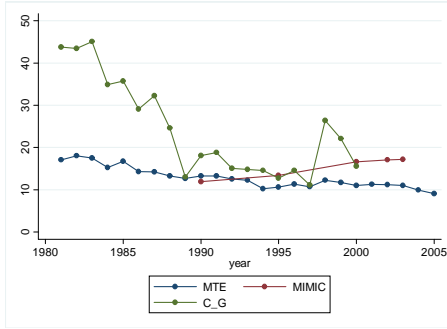
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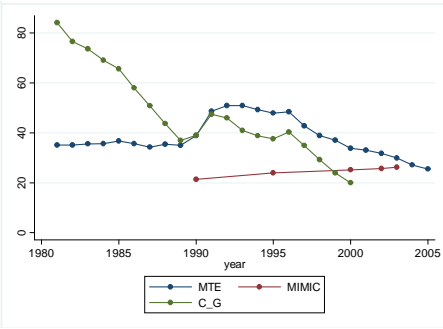
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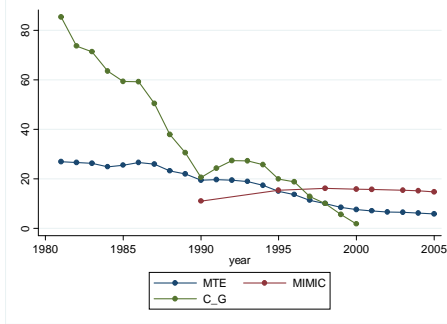
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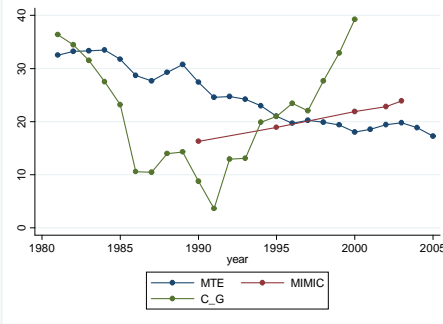
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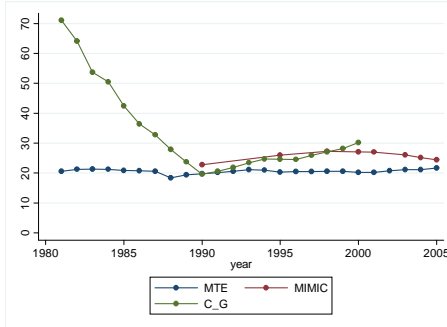
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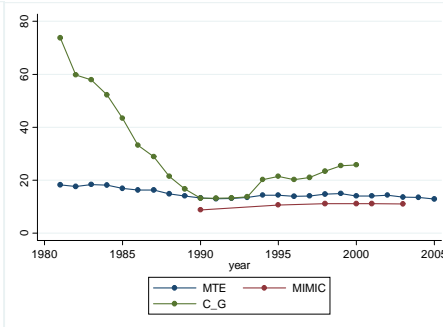
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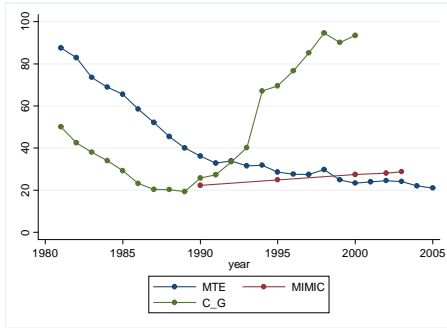
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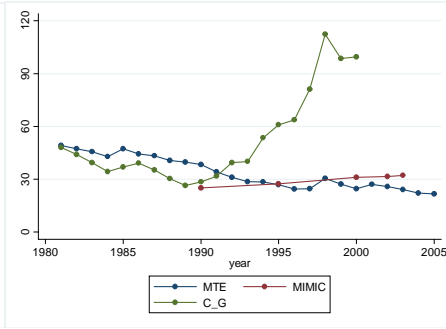
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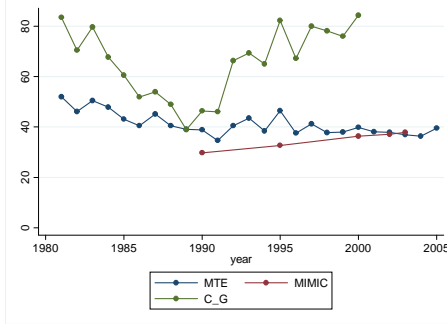
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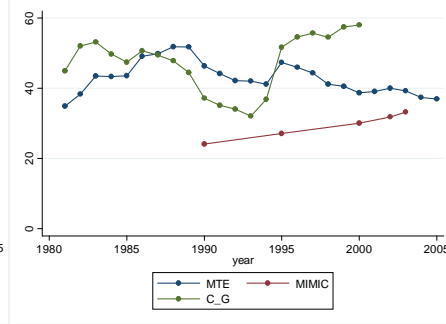
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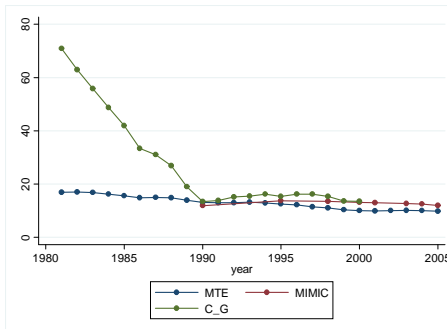
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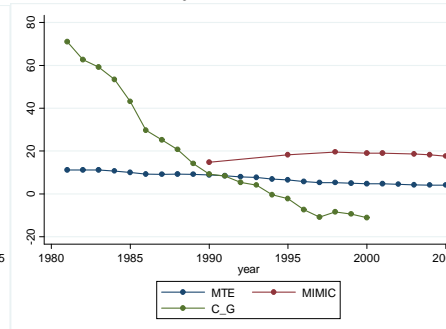
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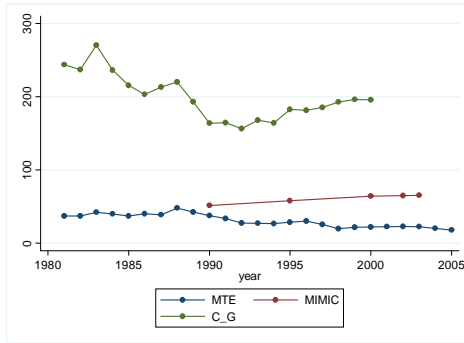
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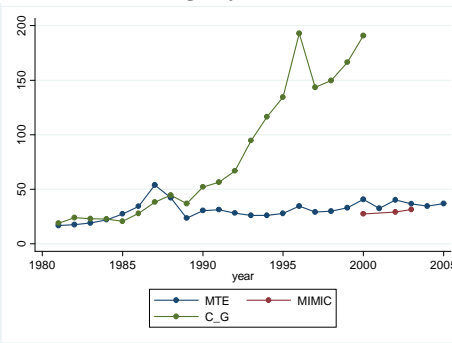
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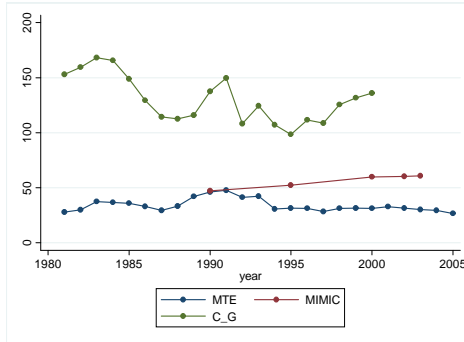
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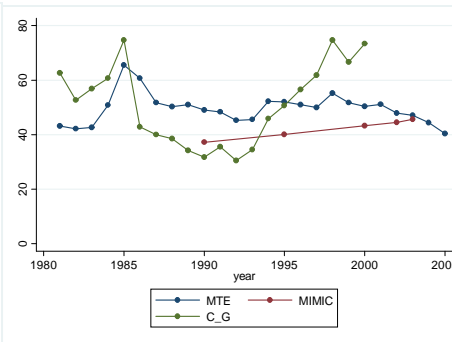
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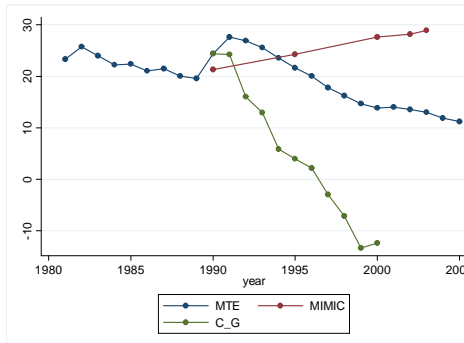
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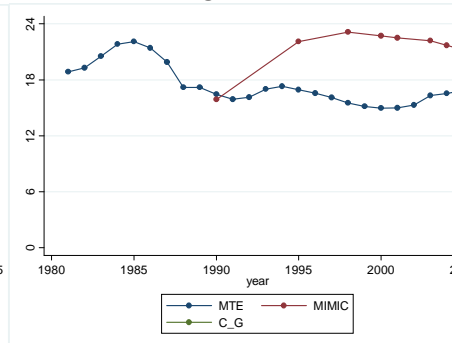
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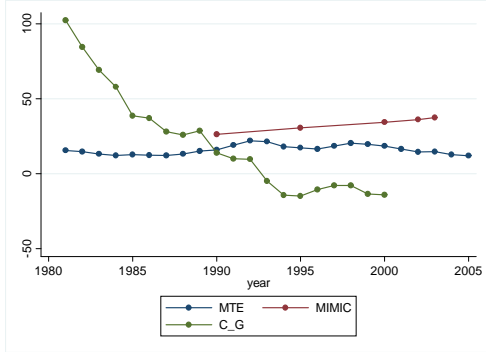
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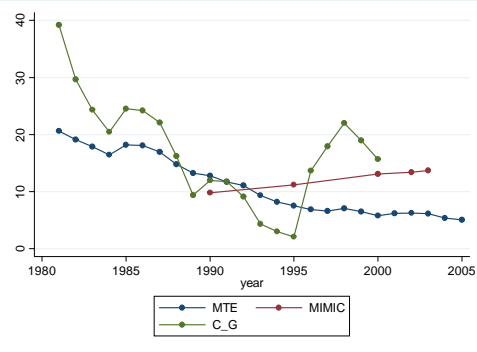
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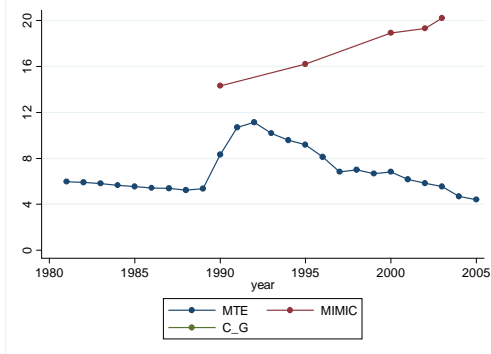
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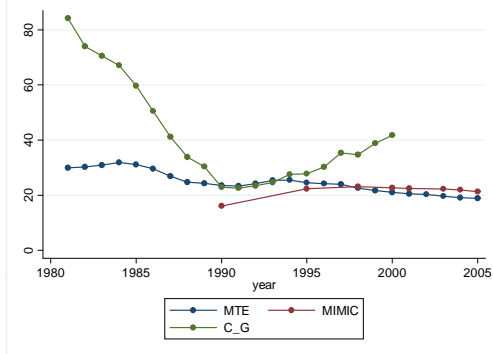
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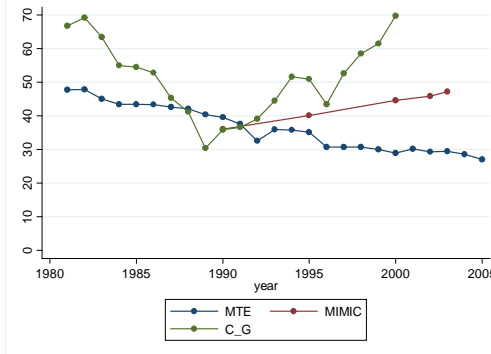
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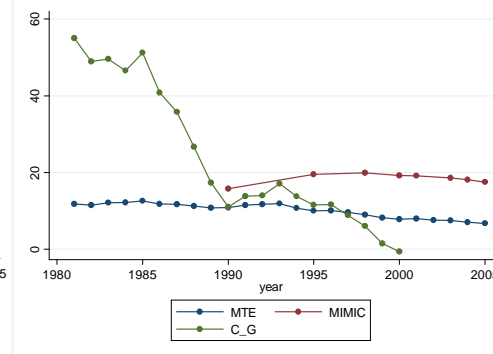
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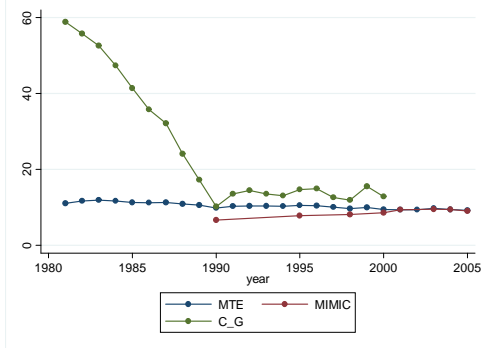
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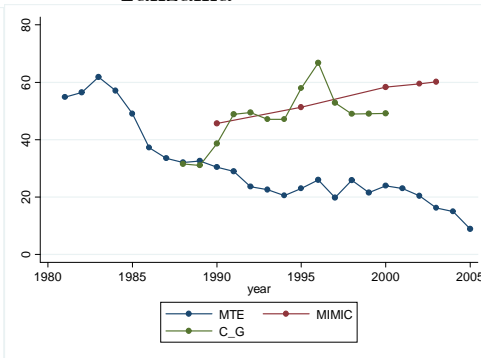
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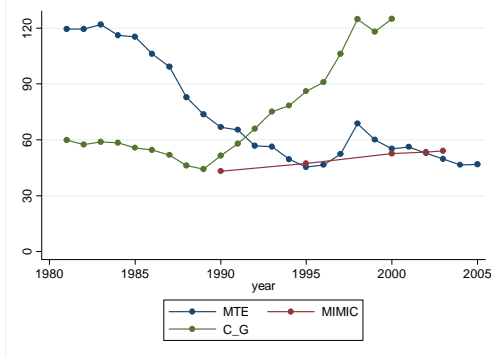
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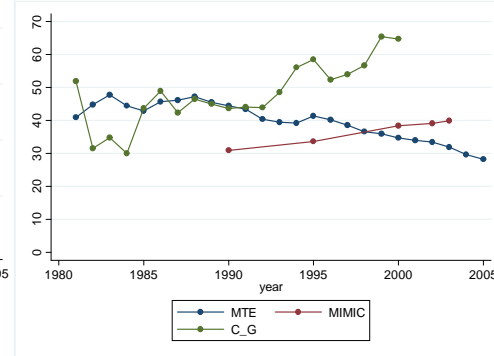
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USA

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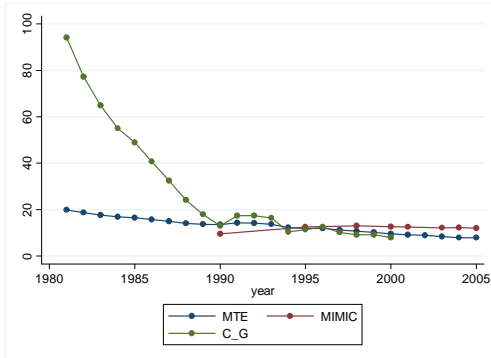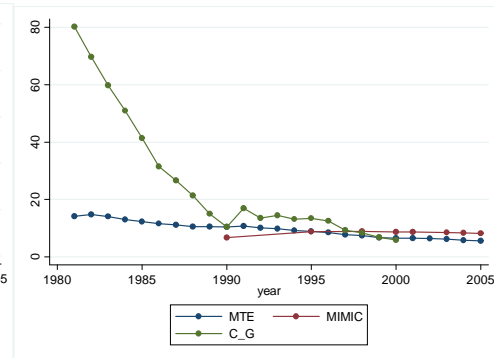
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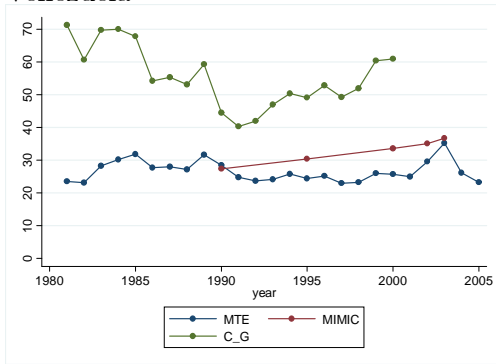
Source: MTE=own calculations; MIMIC= Schneider (2004, 2005); C-G= Chong and Gradstein (2007)

8 Appendix IV- Interpreting dynamics of the shadow economy: some anedoctical evidence

Growth-enhancing reforms in developing countries

In *Botswana* the decrease in the share of unobserved economy during the 1980s may be related to the phase of impressive economic growth started after independence from Britain in 1966. Botswana's economic performance has been built on a foundation of diamond mining, prudent fiscal policies, international financial and technical assistance, and a cautious foreign policy. In particular, it has been noted that good economic policies were chosen in Botswana because good institutions were in place (Acemoglu, Johnson and Robinson, 2002). Analogously, the *Egyptian* unrecorded income strongly decreased during the 1980s. Also this reduction may be related to a phase of particularly high economic growth, following the implementation of a policy regime (*Open Door Policy*) which allowed for a greater role of the private sector and for partial liberalization of the trade sector and of the exchange rate regime. (Dobronogov and Iqbal, 2005). In *Malaysia*, the decade 1985-1995 was characterized by a significant reduction of the unobserved economy and, at the same time, by a rapid economic growth. The Malaysian economic performance was strongly influenced by a series of policies directed to revive economic growth through investment. The reforms from the mid-1980s also involved a process of economic stabilization, privatization, restructuring of state-owned enterprises and, in the area of labor market, the creation of new jobs was emphasized. In particular, these policies focused on trade and financial liberalization, market opening, promotion of small and medium enterprises, antitrust legislation, greater opening to foreign investment, and structural changes toward the development of more technology based industries (Smith, 2000; Harvie-Pahlavani, 2006).

Transition countries

The unobserved economic activity has surged immediately after the collapse of communism in 1989. The unrecorded income has then begun to decrease mainly thanks to market-oriented reforms, based on privatization and price- and trade-liberalization measures, that were undertaken during the 1990s (Havrylyshyn and Wolf, 1999). In particular, in Poland, the reduction in the relative size of unobserved economy may be related to the reforms that removed price controls, eliminated most industrysubsidies, opened markets to international competition. Similarly, in Hungary the

reduction in the relative size of unobserved sector may be associated to the positive effects of price and trade liberalization, tax- and banking-system reforms, introduced by the government in 1990. In Romania, the recovery was stimulated by government policies based on privatization and trade liberalization. Moreover, Romania signed an association agreement with the EU in 1992 and a free trade agreement with the European Free Trade Association (EFTA) in 1993, codifying its access to European markets and creating the basic framework for further economic integration. In the Czech and Slovak Republics the decrease in the relative size of unobserved sector may be explained by the economic reform process- based on privatization, price liberalization and trade openness- that begun immediately after the Velvet Revolution in 1989. Finally, in Bulgaria, reforms were introduced in 1997.

OECD economies

Finally, among the highly industrialized OECD countries, the unrecorded income has rapidly decreased in Ireland in the second half of the 1980s. This reduction may be related to a series of national economic programmes (*Tallaght Strategy*)- started by the government in 1987- designed to contain inflation, ease tax burdens, reduce government spending, increase labour force skills, and reward foreign investment. This strategy transformed the Irish economy, that began the so called *Celtic Tiger* phase, characterized by an unprecedented economic growth (Powell, 2003). Also in Spain, the unobserved income started to decrease in the second half of 1980s. This reduction may be attributed to social and economic policies- introduced in 1985- directed to reduce labor market rigidities and increase employment. Other two labor market reforms were introduced in 1994 and 1997, respectively. These reforms are considered the main causes of the significant increase in the Spanish employment level during the last two decades (Ferreiro and Serrano, 2001; Gil Martin, 2002).

Institutions, policies and economic development. What are the causes of the shadow economy?[*]

Luisanna Onnis[†]

University of Milan Bicocca-DEFAP

May 2010

Abstract

We investigate the distinct roles played by institutions, growth and policies in determining the shadow economy. The sharp distinction between theoretical priors on the institutional determinants of the shadow economy and the technique used for its measurement is the first novel contribution of the paper. The second innovation is that, by exploiting the time series dimension of our panel, we are able to better investigate the link between official output growth and the relative size of shadow economy. The third innovation is that we can contribute to a long-standing controversy about the distinct roles of "institutions" and "policies" in determining economic outcomes.

1 Introduction

The unobserved or shadow economy has attracted considerable attention by economists and policymakers. This is hardly surprising. On the one hand, the unobserved component of national economies accounts for a large share of GDP in developing countries (La Porta and Shleifer, 2008) and plays an important role at least in some developed economies like Belgium, Greece, Italy, Portugal and Spain (Dell'Anno, 2003; Alañón-Pardo and Gómez-Antonio, 2005; Dell'Anno, Gómez-Antonio and Alañón-Pardo, 2007). On the other hand, the existence of a relatively large informal

sector may have important economic consequences. For instance, the productive potential of unofficial firms is typically constrained by limited access to public goods (De Soto, 1989, 2000), but tax evasion also limits governments ability to supply such public goods and may give to unofficial firms a substantial cost advantage (Farrell, 2004; Farrell, Baily and Remes, 2005).

It is possible to identify three different approaches to interpret this phenomenon. The first one sees the unobserved economy as the citizens' response to tax and regulatory pressure by the government. For instance, Choi and Thum (2005) see the entrepreneurs' option to flee to the underground economy as a discipline device that limits corrupt officials' ability to introduce distortions into the economy. Other contributions emphasize the role of institutional quality, i.e. of institutional constraints on discretion of bureaucrats and policymakers, in shaping incentives to enter the official sector of the economy (Friedman, Johnson, Kaufmann, and Zoido-Lobaton, 2000; Torgler and Schneider, 2007). Thus, institutional quality should limit the size of the shadow economy. The second approach emphasizes the inherent inefficiency of unofficial firms (Amaral and Quintin, 2006; De Paula and Scheinkman, 2008) and looks at the formal and informal sectors as two parallel economies, where the inefficient informal sector is bound to recede when growth-enhancing policies raise the skills of the labour force and the quality of the public goods accessible to official firms. In this framework, cross country differentials in the relative size of the shadow economy are strictly related to different stages of economic development. In a similar vein, La Porta and Shleifer (2008) show that the relation between measures of institutional quality and cross country-differentials in the size of the shadow economy disappears if one controls for per–capita income levels. A third approach sees macroeconomic policies - i.e. the level of public expenditure, inflation and taxes - and the relative dimension of the shadow economy as jointly endogenous outcomes. For instance, in Koreshkova (2006), a benevolent Ramsey planner chooses the optimal inflation tax on the informal sector, whose size - in turn - is determined by the private sector incentives to escape income taxes (similar results are obtained in Nicolini, 1998, and Cavalcanti and Villamil, 2003).

This paper investigates the distinct roles played by institutions, growth and policies in determining the shadow economy. To this aim, we must first identify reliable measures of the shadow economy. In contrast with previous contributions [1], we do not rely on estimates based on the

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[1]Loayza (1996), Giles (1999a, 1999b, 1999c), Chatterjee, Chaudhury and Schneider (2003), Giles, Tedds and Werkneh (2002), Tedds and Giles (2002), Dell'Anno (2003), Bajada and Schneider (2005), Schneider (2004, 2005, 2008), Alañón and Gómez-Antonio (2005), Buehn, Karmann and Schneider (2007), Dell'Anno, Gómez-Antonio and

MIMIC latent variable method. This method typically represents the shadow economy in terms of "causal variables" (taxation, regulatory burden, attitudes toward the state) and "likely indicators" (changes in the demand for currency, in the labour force participation rate and in official GDP). [2] Since variables that identify institutional quality are typically related to the standard "causal variables" behind MIMIC estimates, interpreting MIMIC estimates on the grounds of institutional factors would be tautological. For our purposes, we must rely on shadow-economy estimates which are independent from the theoretical priors that drive our subsequent analysis. For this reason, we rely on data supplied by Onnis and Tirelli (2010), who apply a version of the Modified Total Electricity approach (Eilat and Zinnes, 2002) to a panel of 49 countries over the period 1981-2005.[3] This method obtains shadow-economy estimates from electricity consumption data which are filtered to remove the influence of additional factors such as variations in electricity prices and in the relative weight of energy-intensive industrial sectors.

The sharp distinction between theoretical priors on the institutional determinants of the shadow economy and the technique used for its measurement is the first novel contribution of the paper. The second innovation is that, by exploiting the time series dimension of our panel, we are able to better investigate the link between official output growth and the relative size of shadow economy. Our empirical approach is based on the System GMM method, designed for regressions characterized by "small T, large N" panels, regressors that are not strictly exogenous, fixed effects, within-country heteroskedasticity and autocorrelation (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). The third innovation is that we contribute to a long-standing controversy about the distinct roles of "institutions" and "policies" in determining economic outcomes. In this regard, Acemoglu, Robinson and Thaicharoen (2003) support the view that macroeconomic policies play a minor role once the role of institutional variables is accounted for. By contrast, Glaeser, La Porta, Lopez-de-Silanes and Shleifer (2004) support the view that "good policies" should not be seen as a mechanical consequence of a country's institutional setting.

In a nutshell, our results suggest that all the potential interpretations of the shadow economy contain a grain of truth. We do find that growth in the official economy has a negative effect on

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Alañón-Pardo (2007), Brambila-Macias (2008).

[2] The choice of "causal variables" and "likely effects" appears arbitrary (Helberger and Knepel, 1988; Smith, 2002; Hill, 2002; Breusch, 2005).

[3] Given the availability of data on institutional quality, in the following analysis we exclude Hong Kong and use shorter time series (1984-2005).

the size of the shadow economy. But we also find a negative and significant impact for indicators of institutional quality, even after controlling for per capita GDP. In addition, we show that corruption has a negative impact on the shadow economy. In contrast with La Porta and Shleifer (2008), these results suggest that the shadow economy should not be dismissed as the unpleasant side effect of economic underdevelopment. Instead it is related to some specific institutional aspects that may well survive even when the economy reaches higher development stages. This may explain why highly industrialized OECD economies, such as Belgium, Greece, Italy, Portugal and Spain, are characterized by a relatively high share of unrecorded income. Turning to the analysis of macroeconomic policies, we cannot detect any significant effect of inflation on the shadow economy. By contrast, we find that - after controlling for institutional quality and for the level of development - public expenditures still have a negative impact on the shadow economy. We take this as an indirect support of the view that the supply of public goods has a specific positive effect on the choice of "going formal". Finally, we explore the role of corruption on the size of unobserved economy, finding that this effect is always negative and statistically significant, confirming the argument put forward by Choi and Thum (2005): following an increase in corruption, more entrepreneurs will flee to underground activities, but a composition effect - unofficial firms are undersized relative to official ones - will induce a fall in the share of the unobserved economy.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 defines the empirical methodology. Section 4 presents the results. Section 5 concludes.

2   The model

Our analysis is inspired by La Porta and Shleifer (2008), who group the determinants of the unofficial economy into three broad categories: the cost of becoming formal, the cost of staying formal and the benefits of being formal. Given the limited length of available time series data for their definition of entry costs (World Bank, 2010), we cannot examine the influence of the costs of becoming formal on the relative size of unobserved economy. The costs of staying formal include government regulations. Of all these types of regulations[4], those related to workers' welfare are considered the most restrictive and costly in underdeveloped and some developed countries (Loayza, 1996).

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[4]Common types of regulations are those related to environmental protection, allocation of imported inputs, consumer protection and quality control, financial capital availability, and workers' welfare.

As described in Botero, Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2004), regulation of labor markets aiming to protect workers from employers may take four forms. First, governments forbid discrimination in the labor market and endow the workers with some basic rights (maternity leaves, minimum wage, etc.). Second, governments regulate employment relationships, by raising, for example, the costs of both laying off workers and increasing hours of work. Third, governments empower labor unions to represent workers collectively, and protect particular union strategies in negotiations with employers. Fourth, governments themselves provide social insurance against unemployment, old age, disability, sickness and health, or death. A strong protection of worker's rights is, therefore, a cost for the entrepreneurs to remain in the formal sector.[5]

The benefits of being formal are basically related to expanded access to public goods, including direct or indirect participation to international goods markets. Trade is transparent and easier to tax and therefore more difficult to hide in the unobserved economy. Thus, in an open economy only those firms that operate in the official sector fully exploit the advantages from international trade. Moreover, openness is expected to increase the size of registered firms and, given their obstacles to trade, impede the growth of unofficial ones. Registered business may also find it easier to use courts to enforce property rights and adjudicate disputes. By contrast, since unobserved activities are illegal, informal entrepreneurs cannot exercise full property rights over their capital and product. Therefore, contracts related to informal activities cannot be enforced through the judicial system and, thus, their value and usefulness are greatly diminished. The inability to sign enforceable contracts creates uncertainty and increases the transaction and monitoring costs in all business dealings conducted in the unobserved sector (De Soto, 1989; Loayza, 1996).

In addition, both inflation and income taxes play an important role. As discussed in the introduction, inflation is a tax that mostly affects the informal sector (Koreshkova, 2006).[6] Income taxes generate double-edged incentives. A voluminous literature sees tax burden as the key motive for choosing informality. Dessy and Pallage (2001) challenge this view. They point out that formalizing production does not just mean taking an old technology and making it legal. This implies that

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[5]Nipon (1991) estimated that informal firms in Thailand, by ignoring labour-protection laws, saved about 13 to 22 percent of labour wages. Tokman (1992) reported that labour regulations increased costs for small firms in Latin America by an average of around 20 percent.

[6]An opposite view (Giles, 1999; Chong and Gradstein, 2007; Vuletin, 2008) holds that, since inflation tends to be unequal across sectors, it alters income distribution, and this may induce disrespect for tax law. Therefore, the higher the inflation, the larger the size of unobserved sector.

switching from low to high-productivity technologies allows to take advantage of the availability of public infrastructures. Formalization therefore generates a productivity premium which increases with infrastructure quality. Such a premium is an additional opportunity cost of informality. As a consequence, relatively high tax rates may actually increase the costs of being informal, and *vice versa*.

Finally, we consider the role of corruption. The effect of corruption on the relative size of unofficial economy is ambiguous. Hindriks, Muthoo and Keen (1999) see the shadow economy and corruption as complements. This is because in their model the tax payer colludes with tax inspector, convincing the latter to underreport the tax liability of the former in exchange for a bribe. The opposite result obtains in a model by Choi and Thum (2005), where entrepreneurs of unofficial firms risk detection, whereas official firms are subject to bribery payments. If the probability of detection increases with unofficial firm's size (capital stock) and the loss of profits due to bribery payments falls with official firm's size, then the structure of the economy is dualistic, with unofficial firms being undersized relative to the official ones. In this framework, an increase in the official's ability to monitor underground activities may well lead to a fall in the relative size of the shadow economy, because more entrepreneurs will go underground but the relative size of unofficial firms will fall.

Empirically, Johnson, Kaufmann and Zoido-Lobaton (1998) and Friedman et al. (2000) find a positive relationship between corruption and shadow economy, i.e. corruption and unobserved economy are complements. On the contrary, Dreher, Kotsogiannis and McCorriston (2009) support the hypotheses that corruption and shadow economy are substitutes.

We relate such costs and benefits to the three approaches outlined in the introduction. Our modelling strategy therefore accounts for the stage of development (per-capita official income), for the role of institutional quality and for the influence of macroeconomic policy outcomes. Thus we test the following model:

$$SH_{i,t} = \beta_0 + \sum_{j=1}^{h} \beta_j IQ_{j,i,t} + \beta_{h+1} XN_{i,t} + \beta_{h+2} y_{i,t} + \beta_{h+3} G_{i,t} + \beta_{h+4} \pi_{i,t} + \varepsilon_{i,t} \tag{1}$$

where i indexes the countries in the sample and t the time period. SH denotes the size of

the shadow economy as a percentage of the official GDP[7], IQ are h indicators for institutional quality, XN measures trade openness, y is the per-capita GDP (in logs), G is the share of public expenditure, and π is the inflation rate.[8]

2.1 Indicators of institutional quality

We explain here the composition of $\sum_{j=1}^{h} \beta_j IQ_{j,i,t}$. Institutional data from International Country Risk Guide (ICRG) have been often used in the literature (Torgler and Schneider, 2007; Chong and Gradstein, 2007). These data are available for the period $1984 - 2005$. The ICRG risk rating system assigns a numerical value to a predetermined range of risk components for a large number of countries. We adopt the institutional variables most commonly used in the literature:, *rule of law, democratic accountability, government stability, bureaucracy quality* and *corruption*. The variable *rule of law* is the sum of two components. The *law* component assesses the strength of impartiality of the legal system, and the *order* component assesses popular observance of the law. This index ranges between 0 and 6 with increasing quality. We take it as a measure of the benefits of formalization. The variable *democratic accountability* ranges between 0 and 6 with increasing quality. It measures how responsive government is to the electorate. The intuition is that accountability reduces policymakers' rent seeking activities, thus lowering the costs of being formal. The variable *government stability* ranges between 0 and 12 with increasing quality. It measures the government's ability to stay in office and carry out its declared program. The rating is the sum of three subcomponents: *government unity, legislative strength* and *popular support*. We posit that *government stability* is an inverse proxy for political uncertainty, where the latter lowers the benefits from staying in the formal economy. The variable *bureaucracy quality* ranges between 0 and 4. High scores are given to countries where bureaucracy tends to be somewhat autonomous from political pressure and to have an established mechanism for recruitment and training. The interpretation of this variable is ambiguous. On the one hand, it should signal stability in the mechanisms driving the functioning of the publish sector, as it is relatively independent from political

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[7]See the Appendix for a discussion of measurement techniques for the shadow economy.

[8]XN is the standard Exports + Imports to GDP ratio (source: United Nations). Data on y are taken from United Nations, constant (1990) prices, US Dollars. Data on the share of total government spending, as a percent of GDP are taken from Penn World Table. Inflation is measured by the annual growth rate of the GDP implicit deflator (source: World Bank). The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.

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pressures. On the other hand, relative independence from political pressures might correspond to insufficient accountability, leaving room for excessive power of the bureaucratic structure. Finally, the variable *corruption* measures corruption within the political system. It ranges between 0 and 6 (very high level of corruption). As discussed, its relationship with the shadow economy is *a priori* ambiguous. Alternatively, the *corruption perception index* (*cpi*) published by Transparency International measures the degree to which corruption is perceived to exist among public officials and politicians. The *cpi* is based on 13 different expert and business surveys and ranges between 1 and 10 (very high corruption).

As an alternative measure of institutional quality we adopt an *index of economic freedom* (Heritage Foundation). This variable (unfortunately available only for the $1995 - 2005$ subsample) is the simple average of 7 subcomponents- *business freedom*, *fiscal freedom*, *trade freedom*, *monetary freedom*, *financial freedom*, *investment freedom* and *property rights*- and comprises 0 to 10 points. *Business freedom* is a quantitative measure of the ability to start, operate and close a business that represents the overall burden of regulation as well as the efficiency of government in the regulatory process. Fiscal freedom is a measure of the tax burden imposed by governments.[9] Trade freedom is a measure of the absence of tariff and non-tariff barriers that affect imports and exports of good and services. *Monetary freedom* combines a measure of price stability with an assessment of price controls[10]. *Financial freedom* is a measure of banking security as well as a measure of independence from government control. In fact, state ownership of banks and other financial institutions generally lowers the level of available services. *Investment freedom* measures the availability to move the resources into and out of specific activities both internally and across the country's borders without restriction. Finally, the *property rights* component is an assessment of the availability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state. The variables of the data sets ICRG and the *index of economic freedom* are highly correlated.

Finally, as a proxy for the regulation of labor, we use an indicator of the protection of workers' rights that ranges between 0 and 2. [11]

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[9]*Fiscal freedom* includes both the direct tax burden in terms of the top tax rates on individual and corporate incomes and the overall amount of tax revenues as a percentage of GDP.

[10]Both inflation and price controls distort market activity. Price stability without microeconomic intervention is the ideal state for the free market.

[11]Worker's rights may be: (0) severely restricted, (1) somewhat restricted, (2) fully protected (source: Human Rights Dataset).

2.2 Previous empirical evidence on the role of institutions

Several studies empirically analyze the role of institutional quality on the unofficial economy. Johnson et al.'s (1998) investigation of 49 countries in Latin America, the OECD, and the former Soviet Union block finds a statistically significant positive relationship between different measures of corruption and the shadow economy. Similarly, Friedman et al. (2000) test the relationship between unregistered income, bureaucracy, corruption and the legal environment in 69 countries. In a panel-data analysis, Loayza and Rigolini (2006) investigate the role of institutional indicators on the size of unobserved economy, proxied by the percentage of the active labor force that is self employed. They find that, in a sample of 42 countries, informal employment is more prevalent when business flexibility and the rule of law are weaker. Similarly, Torgler and Schneider (2007) find a negative and statistically significant relationship between several measures of the quality of institutions and their MIMIC estimates of the unobserved economy over the periods 1990, 1995 and 2000, in 86, 88 and 100 countries, respectively. In a cross-section analysis, also Chong and Gradstein (2007) find the evidence of a negative relationship between shadow economy and the quality of institutions in around 100 countries during the 1990s. They adopt two groups of estimates of unobserved economy *i)* macro-electric estimates calculated by assuming that elasticity of electricity consumption to gross domestic product decreases in 0.05 from decade to decade; *ii)* MIMIC estimates obtained by Schneider and Klingmair (2003) and Schneider (2005). Chong and Gradstein (2007) do not obtain the same result in a panel data analysis. In this case, the relationship between shadow economy and the quality of institutions is still negative but no longer significant. Finally, by using micro-data on the level of informality [12], also Dabla-Norris, Gradstein and Inchauste (2008) find that more developed and efficient legal institutions reduce the incidence of informality.

3 Methodology

We employ the System GMM technique (Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998) that is considered particularly appropriate for our panel data. This estimator has been, in fact, designed for situations with "small T, large N" panels, independent variables

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[12]Micro data on the level of informality derive from World Business Environment Survey and refer to 4000 firms in 41 countries.

that are not strictly exogenous[13], fixed effects, and heteroskedasticity and autocorrelation within countries. By using this method, we estimate a regression equation transformed by using forward orthogonal deviations and a regression equation in levels simultaneously, with each equation using its own specific set of instrumental variables. In the transformed equation, variables that are not strictly exogenous are instrumented with their lags in levels, while in the equation in levels, variables are instrumented with their own first differences. [14] The use of orthogonal deviations is due to the presence of gaps in our panel data. Proposed by Arellano and Bover (1995), the orthogonal deviations transformation, rather than subtracting the previous observation, subtracts the average of all available future observations.[15] Therefore, orthogonal deviations have the advantage of preserving the panel size.

The consistency of the System GMM estimator depends on whether lagged values of the explanatory variables are valid instruments in the regression. We address this issue by considering three specification tests: the Arellano-Bond test, the Hansen J test and the difference-in-Hansen test. The Arellano-Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the differenced residuals. The first-order serial correlation test usually rejects the null hypothesis. Second-order serial correlation of the differenced residuals indicates that the original error terms are serially correlated and follow a moving average process at least of order one. If the $AR(2)$ test fails to reject the null, the original error terms are, therefore, serially uncorrelated. The Arellano-Bond test is run on differenced residuals even after estimation in deviations. The Hansen J test (robust to heteroskedasticity and autocorellation) tests the overall validity of the instruments, i.e. it tests of whether the instruments, as a group, appear exogenous. Failure to reject the null hypothesis gives support to the model. Finally, the difference-in-Hansen methodology tests the exogeneity of each subgroup of instruments. We split each instrument subgroup in two for difference-in-Hansen purposes, one each for the transformed and level equations. This is especially useful for testing the instruments for the levels equation based on lagged differences of the dependent variable, which are the most suspect in System GMM.

As reported in the literature on GMM methodology, a large collection of instruments, even if valid

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[13]Non strictly exogenous variables are correlated with past and possibly current realizations of the errors.

[14]In our analysis, we consider all the explanatory variables non strictly exogenous variables.

[15]If the original observation-specific errors are $i.i.d.$, then so are the transformed ones (Arellano and Bover, 1995; Roodman, 2006). Moreover, like differencing, taking orthogonal deviations removes fixed effects.

in specification tests, can be collectively invalid in finite samples because they overfit endogenous variables. Tauchen (1986) demonstrates in simulations of very small samples (50-75 observations) that the bias of GMM rises as more instruments, based on deeper lags of variables, are introduced. Similar results are obtained in Ziliak (1997). In Monte Carlo tests of Difference GMM, Windmeijer (2005) reports that, on 8×100 panels, reducing the instruments from 28 to 13 reduces the average bias in the two-step estimate of the parameter of interest by 40%. Following Roodman (2008), we combine two approaches to instrument containment. The first one is to use only certain lags instead of all available lags for instruments.[16] The second one is to adopt the "collapse" suboption which creates one instrument for each variable and lag distance, rather than one for each time period, variable, and lag distance[17].

4   Results

In tables 1-4, we report the results of 16 System GMM regressions. We also report the results of the Arellano-Bond and Hansen tests. As can be readily seen, we always fail to reject the null hypotheses of no (second-order) autocorrelation and exogeneity of the entire group of instruments. The results of the single difference-in-Hansen tests are not reported in the tables. For both the transformed and the level equation, we always fail to reject the null hypothesis of exogeneity for each subgroup of instruments.

Given the relatively large number of regressors, to facilitate discussion we present our estimates in stages (Table 1). The first striking result is that, even if we observe a negative and statistically significant effect of official per-capita GDP, measures of institutional quality retain a significant impact on SH. Variables rule of law, democratic accountability, government stability, and trade openness have the expected negative effects. Bureaucracy quality presents a positive sign, suggesting that, even though independent bureaucracies may be interpreted as a sign of low political risk, their independent role lowers incentives to formalization. As expected, we find evidence of a positive and statistically significant relationship between protection of workers' rights and our estimates of unregistered income. Turning to the analysis of macrroeconomic policies, we find a negative and

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[16]For each variable, the choice of the lags as instruments has been based on the results of the specific difference-in-Hansen tests.

[17]In the paper we present the results obtained adopting the "collapse" option. However, we have obtained the same results without using this option.

significant relationship between the unobserved economy and the share of government spending. By contrast, we cannot find evidence of a significant effect of inflation on the unobserved economy.

To test the robustness of these results, we firstly reduce the cross-sectional dimension of the panel. We re-estimate the regression equation (1), excluding from the panel Germany and the six transition economies. We exclude these countries because of the lower quality of their institutional data before the 1990s. As reported in Table 2 (regression 1), our results survive, with the exception of trade openness. Second, to confirm that our results are not distorted by correlations among the single ICRG institutional indicators[18], we re-estimate equation (1) for the entire panel of countries by using an aggregate indicator of these institutional variables. This aggregate variable has been obtained as the simple average of the four (rescaled) ICRG institutional indicators. The relationship between this aggregate measure and the size of unobserved sector is still negative and statistically significant (Table 2, regression 2). In addition, we substitute the four ICRG institutional variables with the first component of a Principal Component Analysis (PCA).[19] Again, we find a negative and statistically significant relationship between the transformed variable and the share of unobserved economy (Table 2, regression 3). Finally, in alternative to the ICRG institutional variables, we adopt the index of economic freedom. Since inflation and trade openness are used to construct two subcomponents of this variable- i.e. trade freedom and monetary freedom, respectively- we exclude these two variables from the regression equation. As reported in Table 2 (regression 4) the relationship between unobserved income and the index of economic freedom is negative and statistically significant.

Finally, we explore the impact of corruption on the size of unobserved economy (Table 3). Adopting the two alternative measures of corruption, we find that the relationship between unobserved economy and the corruption is always negative and statistically significant, suggesting that the composition effect outlined in Choi and Thum (2005) is dominant. The relationships between unobserved economy and per capita GDP, institutional quality, and public expenditure remain

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[18]Testing the correlation between the ICRG institutional variables, we obtain positive and statistically significant coefficients included between 0.3 and 0.6. Hence, we exclude problems of multicollinearity which arise when the correlation coefficients are close to 0.9.

[19]The Principal component analysis (PCA) involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible.

statistically significant. [20]

5 Conclusions

Theoretical models suggest that the shadow economy is a constraint on economic efficiency. Our results show that triggering faster growth of the official economy is not a panacea for this, even though it has unambiguously beneficial effects. In fact, institutional design and even the choice of government size may determine additional cross-country differences in the relative size of the shadow economy. Thus, both institutional design and public expenditure policies should specifically target private sector's incentives to enter the official economy. This is a promising field of future research.

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[20] For all the regressions of Table 3, we fail to reject the hypotheses of no autocorrelation and exogeneity of the entire group (and individual sub groups) of instruments.

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6   Tables

Table 1- System GMM estimation

Shadow	(1)	(2)	(3)	(4)
Law and order	$-0.02**$	$-0.02***$	$-0.02***$	$-0.02**$
Bureaucratic quality		0.02	$0.04**$	$0.05***$
Democratic accountability			$-0.04***$	$-0.03***$
Government stability				$-0.01*$
Log gdp per capita	$-0.07**$	$-0.09***$	$-0.09***$	$-0.08***$
Openness to trade	$-0.09**$	$-0.07**$	$-0.08**$	$-0.07*$
Protection workers rights				
Public expenditure				
Inflation				
Observations	1030	1030	1026	1026
Second-order correlation	$p=0.88$	$p=0.96$	$p=0.5$	$p=0.7$
Hansen Test	$p=0.17$	$p=0.19$	$p=0.7$	$p=0.4$

Regressions with constant terms and robust standard errors (not reported).

* Statistically significant at 10%. ** Statistically significant at 5%. *** Statistically significant at 1%.

Table 1 *(continued)*

Shadow	(5)	(6)	(7)
Law and order	$-0.02 **$	$-0.04 ***$	$-0.04 **$
Bureaucratic quality	$0.04 ***$	$0.08 ***$	$0.08 ***$
Democratic accountability	$-0.04 ***$	$-0.04 ***$	$-0.04 ***$
Government stability	$-0.01 **$	$-0.01 **$	$-0.01 **$
Log gdp per capita	$-0.09 ***$	$-0.09 ***$	$-0.09 ***$
Openness to trade	-0.03	$-0.08*$	$-0.09*$
Protection workers rights	$0.01 **$	$0.02 **$	$0.02 **$
Public expenditure		$-1*$	$-1.1 **$
Inflation			-0.01
Observations	978	959	947
Second-order correlation	$p = 0.6$	$p = 0.5$	$p = 0.2$
Hansen Test	$p = 0.5$	$p = 0.3$	$p = 0.5$

Regressions with constant terms and robust standard errors (not reported).

* Statistically significant at 10%. ** Statistically significant at 5%. *** Statistically significant at 1%.

Table 2-System GMM estimation

Shadow	(1)	(2)	(3)	(4)
Law and order	$-0.04***$			
Bureaucratic quality	$0.05**$			
Democratic accountability	$-0.04**$			
Government stability	$-0.02***$			
Institutional quality		$-0.03**$		
Institutional quality (PCA)			$-0.04**$	
Index of economic freedom				$-0.06**$
Log gdp per capita	$-0.09***$	$-0.05***$	$-0.05**$	$-0.07**$
Openness to trade	0.03	-0.02	$-0.09*$	
Protection of workers' rights	$0.02**$	$0.02**$	$0.01*$	$0.02*$
Public expenditure	$-0.97**$	$-1.17**$	$-0.91*$	$-0.75*$
Inflation	-0.01	0.00	-0.01	
Observations	839	947	947	462
Second-order correlation	$p = 0.2$	$p = 0.9$	$p = 0.8$	$p = 0.3$
Hansen test	$p = 0.5$	$p = 0.4$	$p = 0.4$	$p = 0.1$

Regressions with constant terms and robust standard errors (not reported).

* Statistically significant at 10%. ** Statistically significant at 5%. *** Statistically significant at 1%.

Table 3-System GMM estimation

Shadow	(1)	(2)	(3)	(4)	(5)
Law and order	$-0.02***$	$-0.02***$	$-0.04***$	$-0.04***$	$-0.02**$
Bureaucratic quality	$0.03**$	$0.03*$	$0.05*$	$0.05**$	$0.05**$
Democratic accountability	$-0.03***$	$-0.03**$	$-0.02**$	$-0.02**$	$-0.02**$
Government stability	$-0.01**$	$-0.01**$	$-0.01**$	$-0.01**$	$-0.01***$
Corruption	$-0.02***$	$-0.02**$	$-0.02**$	$-0.02**$	
CPI					$-0.04***$
Log gdp per capita	$-0.08***$	$-0.07***$	$-0.08***$	$-0.08***$	$-0.16***$
Openness to trade	-0.01	0.01	-0.04	-0.04	-0.04
Protection workers rights		$0.01*$	$0.01*$	$0.01*$	$0.01**$
Public expenditure			$-0.8**$	$-0.8**$	$-0.9**$
Inflation				0.00	0.01
Observations	1026	978	959	947	639
Second-order correlation	$p=0.8$	$p=0.7$	$p=0.9$	$p=0.8$	$p=0.2$
Hansen test	$p=0.6$	$p=0.2$	$p=0.4$	$p=0.6$	$p=0.4$

Regressions with constant terms and robust standard errors (not reported).

* Statistically significant at 10%. ** Statistically significant at 5%. *** Statistically significant at 1%.

7 Appendix

Different techniques may be used to estimate the size of the unrecorded economy. The OECD (2002) identifies three main *macro-model methods*: *i)* the Currency Demand Approach (CDA henceforth)[21] assumes that unobserved transactions are undertaken in the form of cash payments, so as to leave no observable traces for the tax authorities. In this framework, non-measured production can be modelled in terms of stocks or flows of money; *ii)* the latent variable methods (MIMIC)[22] model the unobserved economic activity in terms of two sets of variables. The first one is assumed to determine the size and growth of non-measured production ("causal variables"). The second one is exploited to provide evidence of the missing activities ("likely indicators"); *iii)* the Electricity Consumption method[23] is based on the empirical observation that overall economic activity and electricity consumption move in lockstep. Measures of total (observed and unobserved) GDP growth are therefore obtained by imposing a constant electricity consumption-to-GDP ratio.

All these methods have shortcomings. The CDA is based on the estimate of a currency demand equation where, in addition to conventional controls (income growth, payment habits, etc.), some other variables are included on the basis of theoretical priors about their impact on unobserved transactions. These typically include the direct and indirect tax burden, government regulation, and the social security burden. Critics of this approach point out that: *i)* not all the transactions in the unobserved economy are paid in cash (Isachsen and Strom, 1985) *ii)* if the ratio of currency to current deposits is used as a dependent variable, observed increases in currency demand may due largely to a slowdown in demand deposits rather than to an increase in currency demand caused by activities in the unobserved economy (Feige, 1996) *iii)* CDA estimates of unobserved economy are not significantly robust to changes in the explanatory variables (Hill and Kabir, 1996; Breusch, 2005) *iv)* the assumption that the velocity of money is the same for official and shadow economy is open to criticism (Ahumada, Alvaredo and Canavese, 2007) *v)* the assumption of no unobserved economy in a base year is implausible (Thomas, 1999). The theoretical priors behind the MIMIC model are similar to those who are used to identify the unrecorded economy in the CDA. As "likely causes" of the unobserved economy the MIMIC procedure generally uses the burden of taxation,

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[21] See Cagan (1958), Gutmann (1977) and Tanzi (1980, 1983).

[22] The pioneers of this approach are Frey and Weck (1983, 1984).

[23] See Kaufmann and Kaliberda (1996) and Johnson, Kaufmann and Shleifer (1997).

burden of regulation and citizens'attitudes toward the state (tax morale). As "likely indicators" it uses changes in the labour force participation rate, in official GDP and in the demand for currency. Critics[24] of the MIMIC approach mainly point at the arbitrariness of the variables grouping into causes and indicators. Moreover, the use of variables like taxes and government regulation as likely determinants of the unrecorded economic strongly limits the possibility to explain the MIMIC (and CDA) estimates on the grounds of economic and institutional factors.

Contrary to the CDA and MIMIC methods, the Electricity Consumption approach does not require theoretical priors on the determinants of the unregistered economy. Critics see the assumption of a constant electricity consumption to GDP ratio as a major weakness of the approach. To allow for both country heterogeneity and a time-varying electricity consumption to GDP ratio, several authors[25] have imposed ad hoc values for this key parameter. A more innovative and direct measurement procedure has been presented by Eilat and Zinnes (2002)[26]. Their Modified Total Electricity (MTE) approach filters the influence of additional factors that affect changes in electric consumption in addition to changes in overall economic activity. These additional variables may include changes in relative electricity prices and in the industry-to-GDP share. To the extent that the filtered series of electric usage captures the output-induced changes in electricity consumption, a unitary output elasticity of electricity may then be used for all countries.

Critics[27] see the assumption of a constant electricity consumption to GDP ratio as a major weakness of the approaches based on the electricity consumption. They emphasize, in particular, the potential downward bias caused by energy-saving technological change. Nevertheless, according to the Jevons'Paradox (Jevons, 1865, 1965), the technological progress that increases energy efficiency, tends to increase (rather than decrease) the rate of energy consumption. In fact, in addition to reducing the amount of energy needed for a given use, improved efficiency lowers the relative cost of energy consumption, which increases demand and economic growth, further expanding energy use.

In this paper we adopt the estimates of unrecorded income reported in Onnis and Tirelli (2010). To measure the share of unobserved economy in a large panel of countries, we use the two-stage MTE procedure proposed by Eilat and Zinnes (2002) . First, the series of electricity consumption

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[24]Helberger and Knepel (1988), Smith (2002), Hill (2002), and Breusch (2005).

[25]Kaufmann and Kaliberda (1996), Johnson et al. (1997) and Chong and Gradstein (2007).

[26]Eilat and Zinnes (2002) used the MTE methodology to measure the unobserved economies of 25 transition countries during the period 1995-1997.

[27]Lacko (1998, 1999) and Hanousek and Palda (2006).

growth is filtered to remove the influence of changes in the weight of the industry sector and in relative electricity prices. This is based on the assumption that changes in real price of electricity (in terms of other domestically produced goods) capture the effects of supply shocks and of long term efficiency gains caused by technical change. Such factors are likely to affect electricity prices in all market economies. Differently, changes in the industry share of GDP affect that part of electricity consumption which is directly related to the country-specific evolution in the composition of domestic output, possibly due to different stages of economic development. Second, the growth rate of the unobserved economy is then obtained by subtracting the growth rate of the official economy from the filtered series of electricity consumption growth - where the latter proxies the growth rate of the overall economy. Finally, estimates of the unobserved-economy-to-official-GDP ratios are obtained by applying the estimated changes of unrecorded income to pre-existing base-year figures. [28]

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[28] We have chosen base-year figures that have been largely used in the academic literature. In particular, we have adopted the macroelectric estimates of Johnson et al. (1997)- for the transition economies- and Lacko (1996, 1998)- for the OECD and Developing countries.

The Unobserved Economy and the Velocity of Circulation of Money[*]

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Abstract

In the paper we reverse the standard approach typically followed in the literature on the shadow economy. Instead of exploiting money demand data to extrapolate the dynamics of the shadow economy, we explore the long run effect of shadow economy measures - obtained independently from money demand functions - on money velocity. By doing this, the original contribution of the paper is twofold. First, we improve the understanding of money velocity determinants. Second, we provide an indirect test of the reliability of the estimates on the shadow economy presented in Onnis and Tirelli (2010).

1 Introduction

Unobserved transactions are undertaken in the form of cash payments, so as to leave no observable traces for the tax authorities. Therefore, an increase in the size of the unofficial sector will increase the demand for currency. This is the fundamental assumption of the Currency Demand Approach (CDA). The CDA is one of the most commonly used approaches, applied to many OECD countries.[1] The CDA methodology indirectly measures unrecorded income through the direct estimation of a currency demand equation, where, in addition to conventional controls, i.e. income growth, payment habits, etc., are included other variables on the basis of theoretical priors about their impact on

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[1]See Schneider (1997, 1998), Johnson, Kaufmann and Zoido-Lobatón (1998) and Williams and Windebank (1995).

unobserved transactions. Hence, the amount of money unexplained by the conventional controls are then attributed to variations to those indicators, such as tax burden, government regulation, and the social security burden, associated with the unobserved economic activity.[2] Even though the basic idea of linking the unobserved economy with the demand of money is quite appealing (Rogoff, 1999), the CDA as a tool for measurement of the shadow economy has fallen out of fashion due to a number of serious pittfalls (OECD 2002).

In the paper we reverse the standard approach typically followed in the literature. Instead of exploiting money demand data to extrapolate the dynamics of the shadow economy, we explore the long run effect of shadow economy measures - obtained independently from money demand functions - and money velocity. By doing this, the original contribution of the paper is twofold. On the one hand we improve the understanding of money velocity determinants. On the other hand we provide an indirect test of the reliability of the shadow economy measures presented in Onnis and Tirelli (2010).

To this aim, we must first identify reliable measures of the shadow economy. In contrast with previous contributions [3], we do not rely on estimates based on the MIMIC latent variable method. This method typically represents the shadow economy in terms of "causal variables" (taxation, regulatory burden, attitudes toward the state) and "likely indicators" (changes in the demand for currency, in the labour force participation rate and in official GDP).[4] Given the role played by currency demand in producing estimates of the shadow economy, basing our analysis on MIMIC estimates would lead to almost tautological conclusions. For this reason, we rely on data supplied by Onnis and Tirelli (2010), who apply a version of the Modified Total Electricity approach (Eilat and Zinnes, 2002) to a panel of 49 countries over the period 1981-2005.[5] This method obtains shadow-economy estimates from electricity consumption data which are filtered to remove the influence of

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[2]The currency demand approach was first used by Cagan (1958), who calculated a correlation of the currency demand and the tax pressure for the United States over the period 1919 to 1955. 20 years later, Gutmann (1977) used the same approach but without any statistical procedures. Cagan's approach was further developed by Tanzi (1980, 1983), who econometrically estimated a currency demand function for the United States for the period 1929 to 1980 in order to calculate the shadow economy.

[3]Loayza (1996), Giles (1999a, 1999b, 1999c), Chatterjee, Chaudhury and Schneider (2003), Giles, Tedds and Werkneh (2002), Tedds and Giles (2002), Dell'Anno (2003), Bajada and Schneider (2005), Schneider (2004, 2005, 2008), Alañón and Gómez-Antonio (2005), Buehn, Karmann and Schneider (2007), Dell'Anno, Gómez-Antonio and Alañón-Pardo (2007), Brambila-Macias (2008).

[4]The choice of "causal variables" and "likely effects" appears arbitrary (Helberger and Knepel, 1988; Smith, 2002; Hill, 2002; Breusch, 2005).

[5]Given the availability of data on money demand and interest rates, in the following analysis we exclude Paraguay, Tanzania, Sri Lanka, Bulgaria, Czech Republic, Poland, Romania and Slovakia.

additional factors such as variations in the weight of energy-intensive industrial sectors and relative electricity prices.

For the first time in this paper, we examine the relationship between the dimension of unobserved sector and the velocity of circulation of money in a panel data analysis. Using the group-mean panel Fully Modified Ordinary Least Squares (FMOLS) method proposed by Pedroni (2000, 2001) we find a negative and statistically significant relationship between money velocity and unrecorded economy. This results is robust to different specifications of the estimated model. This implies a positive relationship between unobserved transactions and demand for currency. Therefore, by confirming the plausible assumption that transactions in the unobserved sector are carried out using cash, we also prove the validity of our MTE estimates of unrecorded economy. A striking result we obtain in the paper is that income-related changes in money velocity are more significantly explained by variations in relative size of the shadow economy, whereas variations in official income play a limited role. This result is even stronger if we restrict our analysis to OECD countries, where payments systems are more sophisticated.

The remainder of the paper is organized as follows. Section 2 describes the model . Section 3 describes the data and defines the empirical methodology. Section 4 presents the results. Section 5 concludes.

2   Model identification

According to the standard theory of money demand, money is demanded for two reasons: as a mean of exchange, and as one among several assets in a portfolio. These two reasons lead to the following, common long-run specification of money demand:

$$\frac{M}{P} = f(Y^o, r) \tag{1}$$

where $\frac{M}{P}$ is the real narrow money (M1), Y^o is the real official GDP and r is the nominal interest rate.[6]

To analyze the relationship between the demand for currency and the unobserved economic

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[6]This is the specification used in several studies (Hamori, 2008; Rao and Kumar, 2008). Additional variables like the inflation rate and/or exchange rate are added in some empirical works (Bahamani-Oskooee and Rehman, 2005; Ozturk and Acaravci, 2008; Valadkhani, 2008; Narayan, Narayan and Mishra, 2009).

activity it is possible to extend equation (1):

$$\frac{M}{P} = f(Y^o, Y^u, r) \tag{2}$$

where Y^u is the real unrecorded income. However, to estimate equation (2) may generate serious problems of collinearity between official and unofficial GDP (like in Buehn and Goethel, 2008). As an alternative indirect approach, we suggest to estimate the relationship between the relative size of unobserved economy and the velocity of circulation of money.

The overall amount of money can be considered as the sum of money in the official and unofficial sectors, that is M^O and M^U respectively:

$$\frac{M}{P} = \frac{M^O}{P} + \frac{M^U}{P} \tag{3}$$

After simple manipulations, we can rewrite equation (3):

$$\frac{M}{Y^O P} = \frac{M}{Y^O P}^O + sh \frac{M}{Y^U P}^U \tag{4}$$

where, according to the Equation of Exchange (Fisher, 1911), $\frac{M}{YP}$ is the inverse of the velocity of circulation of money V[7] and sh is the relative size of unobserved economy with respect to official GDP ($\frac{Y^U}{Y^O}$):

$$V = V^O + \frac{1}{sh} V^U \tag{5}$$

We therefore expect a negative relationship between money velocity and unobserved economic activity. Testing this relationship obviously requires that other controls be included, capturing economic determinants of money velocity.

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[7]Fisher's version of the Quantity Theory of Money is expressed in his Equation of Exchange (Fisher, 1911):

$$MV = PT$$

where M is the money stock, V is the velocity of money (that is the average frequency with which a unit of money is spent in a specific period of time), P is the price level and T is the nominal value of transactions. Using the real GDP as a proxy for the volume of transactions, Fisher's equation may be rewritten in this way:

$$MV = PY$$

The modern version of the Quantity Theory indicates that the velocity of money depends on some measure of income and interest rate.[8] As discussed above, the presence of unobserved economic activities may influence the payment habits. A measure of the relative size of unrecorded economy should therefore enter the velocity function along with measures of income and interest rate.

We propose the following specification of the velocity function:

$$\ln V_{i,t} = \alpha_i + \beta_1 \ln r_{i,t} + \beta_2 \ln y_{i,t} + \beta_3 \ln sh_{i,t} + \varepsilon_{i,t} \tag{6}$$

where $\ln V$ is the log of money velocity, $\ln r$ the log of nominal interest rate, $\ln y$ the log of real income, and sh the log of unrecorded income in percent of official GDP.

Considering the interest rate as an opportunity cost of holding money, we expect a positive and statistically significant relationship between $\ln r$ and $\ln V$. However, many developing countries have followed policies based on a regulated interest rate. Therefore, the interest rate might not correspond to the opportunity cost of holding money. Hence, the expected rate of inflation ($E_t \pi_{t+1}$) could be preferred to the nominal interest rate to explain asset substitution between real assets and money (Driscoll and Lahiri, 1983; Akhtaruzzaman, 2008)[9]. The expected sign of anticipated inflation rate is also positive, implying an inverse relationship with holdings and a direct relationship with the velocity of money.

The sign of the correlation between money velocity and real per capita income may depend on the stage of economic development (Fry, 1988). The initial stages in economic development are characterized by increasing monetization of the economy, rapid expansion of monetary transactions and relatively higher demand for money. The income elasticity of money demand becomes highly elastic and the velocity of money is likely to decrease. Differently, the advanced stages are characterized by transaction efficiency, financial innovation, and technological progress which ensure the availability of a wide range of money substitutes. The demand for currency decreases with an acceleration in growth. Therefore, at the initial stage of economic development, we expect a negative correlation between velocity and income but at a later stage, the relationship has presumably a positive sign.

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[8]In several studies, additional factors (like age, urbanization of the population, size of the agricultural sector, financial development) that may affect money demand behaviour and hence, velocity of money, have been examined (Graves, 1980; Driscoll and Lahiri, 1983; Akhtaruzzaman, 2008).

[9]As a proxy for the expected inflation rate for the period $t+1$ we adopt the actual inflation rate at time t (Ravenna and Seppala, 2007).

Finally, according to the literature on the CDA, we expect a negative relationship between the velocity of money and the relative size of unrecorded economy. This hypothesis is based on the assumption that transactions in the unobserved sector are paid in cash, so as to leave no observable traces for the tax authorities. Therefore, the expected sign for the unrecorded income is negative, implying a direct relationship with the demand for currency and an inverse relationship with velocity of circulation of money.

3   Data description and methodology

Estimates of unrecorded income are obtained through the MTE approach.[10] The velocity of circulation of money is the ratio between the nominal official GDP (source: United Nations) and the average annual stock of narrow money (source: International Monetary Found). Data on money market rates, treasury bill rates, and deposit rates are taken from International Monetary Found.[11] The inflation rate is the annual growth rate of Consumer Price Index (source: United Nations). Figures of per capita real GDP are taken from United Nations.

Given the availability of data on money demand and interest rates, we use a panel of 40 countries over the period 1981-2005.[12] The choice of the econometric methodology is, therefore, based on a preliminary stationarity analysis of the variables $\ln V, \ln r, \ln E_t \pi_{t+1}, \ln y$ and $\ln sh$. First, we adopt the Pesaran test for the null of unit root in heterogeneous and unbalanced panels with cross-sectional

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[10]To measure the share of unobserved economy in a large panel of countries, we have used the two-stage MTE procedure proposed by Eilat and Zinnes (2002). First, we have filtered the series of electricity consumption growth to remove the influence of changes in the weight of the industry sector and in relative electricity prices. Our framework is based on the assumption that changes in real price of electricity (in terms of other domestically produced goods) capture the effects of supply shocks and of long term efficiency gains caused by technical change. These factors are likely to affect electricity prices in all market economies. Differently, changes in the industry share of GDP affect that part of electricity consumption which is directly related to the country-specific evolution in the composition of domestic output, possibly due to different stages of economic development. Second, we have obtained the growth rate of the unobserved economy by subtracting the growth rate of the official economy from the filtered series of electricity consumption growth - where the latter proxies the growth rate of the overall economy. Finally, by applying the estimated changes of unrecorded income to pre-existing base-year figures we have obtained our estimates of the unobserved economy. We have chosen base-year figures that have been largely used in the academic literature. In particular, we have adopted the macroelectric estimates of Johnson et al. (1997)- for the transition economies- and Lacko (1996, 1998)- for the OECD and Developing countries.

[11]In the absence of available data on money market rate, we use the treasury bill rate or, alternatively, the deposit rate.

[12]Countries in the sample are Australia, Austria, Belgium, Botswana, Brazil, Canada, Chile, Colombia, Costa Rica, Denmark, Egypt, Finland, France, Germany, Greece, Guatemala, Hong Kong, Ireland, Israel, Italy, Japan, Korea, Malaysia, Morocco, Mexico, Netherlands, Norway, Panama, Peru, Philippines, Portugal, Singapore, Spain, Sweden, Switzerland, Tunisia, Thailand, United Kingdom, United States, and Venezuela.

dependence of the error terms (Pesaran, 2003, 2007). The Pesaran test rejects the null of unit root even if only one series is stationary. Thus, we also perform individual KPSS tests for the null of stationarity (Kwiatkowski, Phillips, Schmidt and Shin, 1992).

The presence of cointegrating relationships between $\ln V, \ln r$ (or $\ln E_t \pi_{t+1}$), $\ln y$ and $\ln sh$ is detected by using the residual-based procedure developed by Pedroni (1999, 2004). The Pedroni group tests have a null of no cointegration for all countries of the panel against the alternative hypothesis of cointegration for at least one country. These tests are based on the assumption of errors cross sectional independence. Following Pedroni (2004), to eliminate some forms of cross-sectional dependence, we include common time dummies in the regression equation.

Given the presence of cointegrated time series, we estimate the velocity of money by using the group-mean panel Fully Modified Ordinary Least Squares (FMOLS) method proposed by Pedroni (2000, 2001). The group-mean FMOLS estimator (based on the between dimension of the panel) is the simple average of individual FMOLS estimators. This estimator allows for the heterogeneity of the panel, for the effects of autocorrelation of the errors, and for the potential long-run endogeneity of the regressors. As noted by Pedroni (2000, 2001), the group-mean FMOLS estimator may suffer from size distortions in the presence of cross-sectional dependence of the errors. Thus, in order to eliminate some forms of cross-sectional dependence, we include common time dummies in the regression equation.

4   Results

According to the Pesaran test, only for the variables $\ln V$ and $\ln y$ we fail to reject the null hypothesis that all the time series are not stationary. As reported in Table1, we find evidence of stationarity for the variables $\ln r$, $\ln E_t \pi_{t+1}$ and $\ln sh$. According to the separate KPSS tests, a significant portion of series of each relevant variable have a unit root. All the variables in first differences are stationary.

The results of the Pedroni group tests are reported in Table 2. We find evidence of cointegrating relationships between $\ln V, \ln r$ (or $\ln E_t \pi_{t+1}$) $\ln y$ and $\ln sh$. Given that the Pedroni cointegration test statistics may suffer from size distortions when the time dimension of the panel is not significantly large with respect to the cross sectional dimension (Pedroni, 2004), we apply the same

cointegration analysis to two subgroups of the panel with $T > N$.[13] These additional tests confirm the initial results. However, the test of Pedroni rejects the null of no cointegration even if the residuals of a pooled OLS estimation of (6) are stationary only for one country. Therefore, to determine whether the residuals of each of the 49 cross-sections of equation (6) are stationary we performed separate ADF, Phillips-Perron and KPSS unit root tests. These values demonstrate that the OLS residuals are stationary for a significant portion of countries.

The FMOLS estimation results for the entire panel of countries are reported in Table 3. As expected, the relationship between the velocity of circulation of money and the relative size of unobserved economy is negative and statistically significant. Also the influence of per capita GDP is negative and significant. The relationship between money velocity and the nominal interest rate is positive and significant in the full model.

We repeat the estimation procedure by using the anticipated inflation rate as an alternative measure of opportunity cost of holding money. As reported in Table 4, the relationship between money velocity and the relative size of unrecorded economy is still negative and statistically significant. The relationship between the velocity of circulation of money and the expected rate of inflation is positive and statistically significant, while the relationship between $\ln V$ and $\ln y$ is no longer significant.

The sub sample of 19 non OECD countries includes 9 countries characterized by episodes of hyperinflation (inflation rates $\geq 40\%$).[14] Specific episodes of hyperinflation, related to periods of economic and financial crisis, may lead to ambiguous results on the influence of unobserved economy on the velocity of money. To prove the robustness of our results, we therefore exclude these 9 countries from the estimation procedure. The FMOLS estimation results for the sub panel of 31 countries are reported in Table 5 (regressions 1 and 2). The velocity of money continues to be negatively affected by the relative size of unobserved sector. The coefficients for $\ln y$, $\ln r$ and $\ln E_t \pi_{t+1}$ are positive and statistically significant.

As noted by Pedroni (2000), the group-mean FMOLS estimator may suffer from size distorsions when N is large relative to T. Thus, we have splitted the sub panel of 31 economies in two smaller groups of countries- 10 developing countries and 21 OECD economies- with T large relative to N.

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[13]We have tested the presence of cointegration in 21 OECD countries and 10 non OECD countries.

[14]Brazil, Colombia, Costa Rica, Guatemala, Israel, Mexico, Peru, Philippines, and Venezuela.

Table 5 reports the regression results for these two sub panels of countries. For the group of 10 developing countries (regressions 3 and 4), the relationship between $\ln V$ and $\ln sh$ continues to be negative and statistically significant. Adopting the anticipated inflation rate, the relationship between $\ln V$ and $\ln y$ is now negative and significant. Considering the sub panel of 21 OECD countries, as expected, the sign of unobserved economy is still negative (regression 5).[15]

5 Conclusions

The nature of the unobserved economy makes difficult to measure its magnitude, and to use such measures in econometric models designed to aid policy makers.

In this paper we use the MTE estimates presented in Onnis and Tirelli (2010) to analyze the relationship between the velocity of circulation of money and the relative size of unobserved sector in a panel of 40 countries for the period 1981-2005. We find a negative and statistically significant relationship between the velocity of circulation of money and the relative size of unobserved economy. This result is robust to sub-sample analysis. Confirming the plausible assumption that transactions in the unobserved sector are carried out using cash, we also prove the validity of our MTE estimates of unrecorded economy. Concluding, according to our expectation, the sign of unrecorded income is negative, implying a direct relationship with holding cash and an inverse relationship with the velocity of money.

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[15] For the OECD countries we are not interested in the relationship between the velocity of circulation of money and the expected inflation rate.

6 Tables

Table 1. Pesaran test for heterogeneous panels

H0: all the time series are not stationary; H1: at least one series is stationary

τ=individual linear trends

	$Pescadf$	$Pescadf\ (\tau)$
lnV	-0.8	-1.4
lnr	$-5.8*$	$-6.7*$
$lnE\pi$	$-7.4*$	$-7.2*$
lny	-0.8	2
$lnsh$	$-4.8*$	$-3.4*$
$\Delta \ln V$	$-9.4*$	$-6.5*$
$\Delta \ln r$	$-14.6*$	$-11.5*$
$\Delta \ln E\pi$	$-12.9*$	$-3.7*$
$\Delta \ln y$	$-9.5*$	$-8.4*$
$\Delta \ln sh$	$-10.5*$	$-7.9*$

Note: The statistics are asymptotically distributed as a standard normal with a left hand side rejection area. A * indicates the rejection of the null hypothesis of nonstationarity at least at the 5 percent level of significance.

Table 2. Pedroni residual-based cointegration test

H0: no cointegration for all countries; H1: for at least one country there is cointegration

Group statistics	(1)	(2)
$Rho - statistic$	1.7	2.3
$PP - statistic$	$-6.2*$	$-3.6*$
$ADF - statistic$	$-2*$	$2.9*$

Note: All reported values are asymptotically distributed as a standard normal. The Pedroni tests are left-sided. A * indicates the rejection of the null hypothesis of no cointegration at least at the 5 per cent level of significance.

(1) Equation 6 with lnr

(2) Equation 6 with $\ln E_t \pi_{t+1}$

Table 3. FMOLS estimation

Dependent variable: $\ln V$

	(1)	(2)	(3)	(4)
$\ln r$	0.55	0.44	0.13	0.5*
$\ln y$			−0.04*	−0.02*
$\ln sh$		−2.37*		−2.48*
countries	40	40	40	40

Note: Regressions with time dummies. t-stats (not reported) are for $H_0 : \beta_i = 0$ for all i vs $H_1 : \beta_i \neq 0$ for all i. A * indicates the rejection of the null hypothesis of no cointegration at least at the 5 per cent level of significance.

Table 4. FMOLS estimation- alternative estimates with the expected inflation rate

Dependent variable: $\ln V$

	(1)	(2)	(3)	(4)
$\ln E_t\pi_{t+1}$	1.48*	0.52*	1.07	0.62*
$\ln y$			0.11	0.04
$\ln sh$		−2.44*		−1.89*
countries	40	40	40	40

Note: Regressions with time dummies. t-stats (not reported) are for $H_0 : \beta_i = 0$ for all i vs $H_1 : \beta_i \neq 0$ for all i. A * indicates the rejection of the null hypothesis of no cointegration at least at the 5 per cent level of significance.

Table 5. FMOLS estimation- sub panel analyses

Dependent variable: $\ln V$

	(1)	(2)	(3)	(4)	(5)
$\ln r$	2.6*		0.43*		3.25*
$\ln E_t\pi_{t+1}$		1.3*		-0.3	
$\ln y$	0.17*	0.16*	-0.06	-1.11*	0.31*
$\ln sh$	-1.58*	-1.25*	-1.32*	-1.22*	-4.45*
countries	31	31	10	10	21

Note: Regressions with time dummies. t-stats (not reported) are for $H_0 : \beta_i = 0$ for all i vs $H_1 : \beta_i \neq 0$ for all i. A * indicates the rejection of the null hypothesis of no cointegration at least at the 5 per cent level

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