SOME NEW ESTIMATES OF SHADOW ECONOMY FOR 80 COUNTRIES USING POOLED MEAN GROUP ESTIMATOR

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ABSTRACT

The purpose of this study is to estimates the size of the shadow economy for 80 countries from nine regions spanning the period 1975-2012 based on Tanzi-type currency demand approach (CDA). This study contributes to the literature in three distinct ways. First, we augment CDA regression with a macroeconomic uncertainty index (MUI). Second, the construction of the uncertainty index is based on the dynamic factor model (DFM). Third, the pooled mean group (PMG) estimator allows in capturing the heterogeneity across countries in the short-run dynamics but imposing restrictions in the long-run parameters. The results confirm the existence of the long-run equilibrium relationship among the variables examined. All coefficients show expected signs along with statistical significance. More importantly, the macroeconomic uncertainty index variable show positive relationship, suggesting that public tend to hold more currency in an uncertain macroeconomic environment. In addition, we observe that developing regions (ranging from 19.9% to 37.3%) exhibit relatively large size of the shadow economy. On the contrary, developed regions have a considerable smaller estimate (ranging from 13.7% to 19.0%) of the size of shadow economy. On average, the world estimate of the shadow economy as a percentage of GDP is about 23.1%.

Keywords: Shadow Economy; Currency Demand; Macroeconomic Uncertainty; Pooled Mean Group.

1. INTRODUCTION

The aim of this study is to estimate the size of the shadow economy for 80 countries over the period 1975-2012 using the currency demand approach (CDA). The present study intends to contribute to the empirical literature in threefold. First, we highlight the need to incorporate a measure of macroeconomic uncertainty in computing the size of the shadow economy. The problem is that the impacts of macroeconomic uncertainty are not

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limited to the formal economy, but also extended to the shadow economy. It is argued that individuals tend to participate in the shadow economy in the period of economic hardship by under reporting their actual income as households are uncertain of the future income levels; by improving their personal finances in order to compensate for lost income (Schneider & Kearney, 2013); and by increasing their precautionary saving balances by holding more currency.

Second, we modelled the macroeconomic uncertainty index by means of dynamic factor model. To reflect uncertainty about macroeconomic conditions, an array of indicators consisting of real GDP per capita, interest rate, total tax revenue to GDP ratio, inflation rate, and exchange rate were used to construct the index. As opposed to other quantitative measures, the macroeconomic uncertainty index is designed to be a better measure with greater coverage of a macroeconomic perspective. Factor models can deal with various variables without lack of degrees of freedom that usually encountered in regression analysis. Moreover, the idiosyncratic movements which contain measurement error and local shocks can be eliminated, yielding a more reliable signal for policy makers.

Third, we use the pooled mean group (PMG) estimator proposed by Pesaran et al. (1999) to examine the long-run relationships between currency demand and its other determinants for the nine regions, namely; East Asia and Pacific (EAP), Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), Middle East and North, Africa (MENA), South Asia (SAS), Sub-Saharan Africa (SSA), high income OECD, high income non-OECD, and euro area (EURO) regions This estimator has advantage over the standard estimators since it allows the heterogeneity across countries in the short-run dynamics but imposes homogeneity restrictions in the long-run coefficients. However, empirical studies using larger panel (for instance, Alm and Embaye, 2013; Elgin and Oztunali, 2012 and Schneider et al., 2010) estimated the shadow economy without considering the heterogeneity across countries. In the case of panel data the estimation of the size of the shadow economy should be carried out by accounting for cross-country heterogeneity.

This is because each region has its own characteristics and dynamics, especially concerning the differences of tax policies and socio-economic characteristics. For instance, based on the estimates of the size of shadow economy by Schneider et al. (2010), Latin America and the Caribbean (LAC), Sub-Saharan Africa (SSA), and Europe and Central Asia (ECA) have the largest estimates at 41.1%, 40.2%, and 38.8% and the OECD (high income) countries have the smallest size of about 17.1%, indicating that there is great heterogeneity between regions. More specifically, each region is also characterized by considerable heterogeneity where the size of the shadow economy in LAC (the largest share of the shadow economy) varies from 25.3% in Argentina to 66.1% in Bolivia; while in high income OECD countries the size of the shadow economy ranges from the lowest of 8.5% in Switzerland to 27.2% in Poland.

The paper is organized as follows. In the next section we discuss the currency demand model use to estimate the size of the shadow economy. In section 3, we discuss the pooled mean group estimator used to estimates the currency demand model. In section 4, we discuss the empirical results. The last section contains our conclusion.

2.   LITERATURE REVIEW

2.1.   *The currency demand model approach (CDA)*

The currency demand approach (CDA) is considered as one of the most well-recognized and popular methods in estimating the size of the shadow economy. Table 1 shows that there have been increasing empirical literature estimating the size of the shadow economy using the CDA method. Basically, CDA is based on the idea of Cagan (1958) and was later extended by Tanzi (1983) who incorporated an econometric estimation on currency demand equation for the United States economy from 1930-1980. The idea behind this approach assumes that shadow economy transactions are undertaken in the form of cash which leave no trace. Transactions involving cash are difficult to trace as compared to those activities using other assets or registered in any financial institutions. For example, a rise in the tax burden implies stronger incentive to engage in cash-intensive underground economic activities, and hence increase the demand for cash. In other words, the CDA provides an indirect measure of the shadow economy by estimating how much cash used for shadow transactions with assumption about the equality of velocity between the cash used in the unofficial and the official economy (Tanzi, 2002).

Since currency in circulation is a subset of the money demand, thus, the currency demand is modelled as a function of a scale variable (often measured by real income) to account for transactions demand, the opportunity cost of holding currency (represented by interest rate), and additional variables that might influence the behaviour of currency holdings. Based on the theoretical arguments from standard demand approaches, macroeconomic uncertainty, therefore, may affect the demand for currency in two ways. We follow Özdemir and Saygili (2013, p.317) by interpreting macroeconomic uncertainty "as the periods that are characterized by increased negative sentiments of economic agents regarding the state of the economy. Hence, pessimism about the economy is considered to be the heightened periods of economic uncertainty". In such environment, economic agents become more uncertain and pessimistic about the future economic activities. This would cause investors and businessmen to lose confidence (Özdemir & Saygili, 2013) which induces public to take a precautionary measure by holding more cash, and increases the shadow economic activities. But, there is another effect where macroeconomic uncertainty can affect people to lost trust and confidence in government policies by switching the liquidity preference to hold more saver assets instead of increasing their cash holding, and reduces the size of the shadow economy. We then argue that currency ratio is sensitive to the macroeconomic uncertainty measure. The role of macroeconomic uncertainty in estimating the size of the shadow economy may even be more important than its role under money demand models as both uncertainty and shadow economy estimates are unobservable. Therefore, there are serious consequences for ignoring the uncertainty measure in the estimation of the CDA, which is also similar to those problems arise in estimating money demand functions.

Motivated by the augmented money demand function and following Tanzi (1983) and other subsequent studies (Alm, 2012; Bajada, 1999; Dell'Anno & Halicioglu, 2010), the augmented CDA function incorporating the macroeconomic uncertainty index (MUI) in a panel setting can be specify as:

Table 1: Size of the shadow economy using the CDA model

Authors	Period	Countries	Size of the shadow economy (of GDP or GNP)
Kirchgässner (1983)	1955-1980	West Germany	2.0%-10.3% (Tanzi method); 2.1%-11.2% (Klovland method)*
Tanzi (1983)	1930-1980	United States	2.8% (Average tax rate); 4.2% (Weighted average tax rate)*
Klovland (1984)	1952-1982	Norway, Sweden	3.0%-20.0%
Schneider (1986)	1952-1982	Denmark	6.1%-11.0%*
Schneider and Lundager (1986)	1954-1982	Denmark, Norway, Sweden	Using marginal income tax rate: 4.9% (Denmark); 5.1% (Norway); 6.3% (Sweden)*
Ahmed and Ahmed (1995)	1960-1990	Pakistan	41.8% (Currency ratio); 44.4% (Currency bearer bond ratio)
Bagachwa and Naho (1995)	1968-1990	Tanzania	15.90%
Bajada (1999)	1966-1996	Australia	About 15.0%
Kasipillai, Baldry, and Prasada Rao (2000)	1971-1994	Malaysia	6.80%
Schneider (2000)	1956-1998	Austria	3.80%
Gadea and Serrano-Sanz (2002)	1964-1998	Spain	11.0%-24.0%
Faal (2003)	1964-2000	Guyana	54.10%
Maurin et al. (2006)	1973-1999	Trinidad & Tobago	About 25.0%
Carolina and Pau (2007)	1988-2004	The Netherlands Antilles	About 5.0%-9.0% (Tanzi method); About 8.0%-14.0% (Adjusted Tanzi method)
Hernandez (2009)	1979-2005	Peru	Tax burden: 48.5% - 50.3% (Johansen), 64.8% - 66.2% (ADL); Government expenditure/GDP: 42.1%-43.7% (Johansen), 72.9%-76.5% (ADL)
Dell'Anno and Halicioglu (2010)	1987-2007	Turkey	10.7% - 18.9%
Alm and Embaye (2013)	1984-2006	111 countries	31.7% (Overall); 16.9% (OECD); 24.3% (Non-OECD high-income); 33.4% (Upper-middle-income); 37.2% (Lower-middle-income); 38.2% (Low-income)
Dobre and Davidescu (2013)	2000-2010	Romania	45% - 37.4%
Ardizzi, Petraglia, Piacenza, and Turati (2014)	2005-2008	91 Italian provinces	17.5% (Baseline); 26.1% (Without criminal)
Kiani et al. (2015)	1975-2010	Pakistan	26.9%*

Note: Asterisk, * refers to percntage to Gross National Product.
Source: Author's own compilation, by chronological order of study.

$$\ln\left(\frac{C}{M2}\right)_{it} = \theta_0 + \theta_1\ln(TAX)_{it} + \theta_2\ln(R)_{it} + \theta_3\ln(YPC)_{it} + \theta_4\ln(MUI)_{it} + \mu_{it} \quad (1)$$

where i, t denote for country i in year t, $\frac{C}{M2}$ is the ratio of currency in circulation to broad money supply (M_2), TAX is the average tax rate, R is the real interest rate, YPC is the real per capita income, MUI is the macroeconomic uncertainty index, and μ is the error term.

As noted by Cagan (1958), as income rises, the demand for deposits increases because services of deposits are more safer than holding currency. Hence, the level of economic development is expected to be inversely related to the shadow economic activities by replacing the currency holdings with checks which in turn, leading to a decline in currency ratio. Thus, the estimated coefficient for θ_1 is expected to be positive while the parameter estimates for real interest rate (θ_2) and income per capita (θ_3) are expected to be negatively related with currency holdings. On the one hand, the precautionary demand for currency arises when uncertainty is high; while on the other hand, a rise in the macroeconomic uncertainty causes people to hold less currency due to substitution effect. Therefore, there is no clear sign for the MUI coefficient, (θ_4).

2.2.　*Measuring macroeconomic uncertainty index*

There is a wide range of methods available for constructing the uncertainty measures. This study adopts the dynamic factor model (DFM) to construct MUI for each country. This is because DFM method has some major advantages over other methods (Breitung & Eickmeier, 2006). Due to limited data availability and low-frequency observations (annual observations), we consider several potential indicators namely economic activity (real GDP per capita), monetary policy (interest rate), fiscal policy (total tax revenue to GDP ratio), inflation rate, and exchange rate that could reflect uncertainty about macroeconomic conditions. A higher value of this index implies that the macroeconomic environment is more uncertain and volatile. Basically, the DFM is applied to model multivariate time series as linear function of unobserved factors and disturbances. The unobserved factors may follow a vector autoregressive structure. Based on Stock and Watson (1998), a standard DFM has the following form:

$$Y_t = Pf_t + \varepsilon_t \tag{2}$$

$$f_t = A_1f_{t-1} + A_2f_{t-2} + \cdots + A_{t-q}f_{t-q} + \mu_t \tag{3}$$

where Y_t is a $(k \times 1)$ vector of dependent variables, P is a $(k \times n_f)$ matrix of parameters (factor loadings), f_t is a $(n_f \times 1)$ vector of unobservable factors, ε_t is a $(k \times 1)$ vector of disturbances, A_i is a $(n_f \times n_f)$ matrix of autocorrelation parameters, and μ_t is a $(k \times 1)$ vector of idiosyncratic disturbances.

In the next step, we formulate the DFM for each country in each region as follow:

$$Y_{jt} = P_jf_t + \varepsilon_{jt} \tag{4}$$

$$f_t = A_1f_{t-1} + A_2f_{t-2} + \cdots + A_{t-q}f_{t-q} + \mu_t \tag{5}$$

where $j = 1, 2, \ldots, N$ indexed for countries in each region[1], Y_{jt} is a $(k_j \times 1)$ vector of dependent variables of country j[2], P_j is a $(k_j \times n_f)$ matrix of parameters (factor loadings), f_t is a $(n_f \times 1)$ vector of unobservable factors, ε_{jt} is a $(k_j \times 1)$ vector of disturbances, A_i is a $(n_f \times n_f)$ matrix of autocorrelation parameters, and μ_t is a $(k \times 1)$ vector of idiosyncratic disturbances. We model their demeaned variables as linear function of an unobserved factor that follows a first-order autoregressive, AR(1) process[3]. The parameters of DFM were estimated using maximum likelihood (ML). f_t is estimated as a MUI to measure the macroeconomic uncertainty conditions of each country.

3. METHODOLOGY

We use the pooled mean group estimator (PMG) proposed by Pesaran et al. (1999) to formulate the dynamic heterogeneous panel models. The PMG estimator allows the intercept, short-run coefficients and error variance to be varied across groups, but imposes homogeneity restrictions on the long-run coefficients over the cross-section[4]. For example, by specifying a ARDL (1,1,1,1,1) in a panel setting, we have:

$$\ln\left(\frac{C}{M2}\right)_{it} = \mu_0 + \sum_{j=1}^{p} \lambda_j \ln\left(\frac{C}{M2}\right)_{i,t-j} + \sum_{j=0}^{q} \delta_{1j} \ln(TAX)_{i,t-j} + \sum_{j=0}^{q} \delta_{2j} \ln(R)_{i,t-j}$$
$$+ \sum_{j=0}^{q} \delta_{3j} \ln(YPC)_{i,t-j} + \sum_{j=0}^{q} \delta_{4j} \ln(MUI)_{i,t-j} + \varepsilon_{it} \qquad (6)$$

where $i = 1, \ldots, N; t = 1, \ldots, T$. $\ln$ refers to natural logarithm, $\frac{C}{M2}$ is currency in circulation to broad money supply (M_2) ratio, TAX is the average tax rate (%), R is the real interest paid on saving deposits (%), YPC is the real income per capita (US$), MUI is the macroeconomic uncertainty index, and ε is the error term. The long-run model as per Equation (1) can be derived when; $\theta_0 = \left(\frac{\mu_0}{1-\lambda_j}\right)$ is the constant term, $\theta_1 = \left(\frac{\delta_{10}+\delta_{11}}{1-\lambda_j}\right)$, $\theta_2 = \left(\frac{\delta_{20}+\delta_{21}}{1-\lambda_j}\right)$, $\theta_3 = \left(\frac{\delta_{30}+\delta_{31}}{1-\lambda_j}\right)$, and $\theta_4 = \left(\frac{\delta_{40}+\delta_{41}}{1-\lambda_j}\right)$ are the long-run coefficients.

The short-run model or the error-correction equation can be defined as follow:

$$\Delta\ln\left(\frac{C}{M2}\right)_{it} = \alpha + \phi ECT_{t-1} + \delta_{10i}\Delta\ln(TAX)_{it} + \delta_{20i}\Delta\ln(R)_{it} + \delta_{30i}\Delta\ln(YPC)_{it}$$
$$+ \delta_{40i}\Delta\ln(MUI)_{it} + \omega_{it} \qquad (7)$$

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[1] For instance, $j = 1, 2, \ldots, 11$ for EAP, SSA, high income OECD, and EURO, $j = 1, 2, \ldots, 9$ for LAC, $j = 1, 2, \ldots, 8$ for ECA and high income non-OECD, $j = 1, 2, \ldots, 6$ for LAC, and $j = 1, 2, \ldots, 5$ for SAS.

[2] Macroeconomic indicators for each country, and the details are provided in Appendix B.

[3] Data transformation also form part of initial preparation of data before data analysis. In doing so we take the first-difference of each variable and then the demeaned variables are obtained by subtracting the mean and dividing by the standard deviation.

[4] As claimed by Pesaran et al. (1999), the reason behind the expecting of the common long-run equilibrium relationships across countries because of budget or solvency constraints, arbitrage conditions, or common technologies that could affect all countries in the same way.

where $\phi = -(1 - \lambda_j)$, is the error-correction speed of adjustment, and the error-correction term (ECT) is derived by $\ln\left(\frac{C}{M2}\right)_{i,t-1} - \theta_0 - \theta_1\ln(TAX)_{i,t-1} - \theta_2\ln(R)_{i,t-1} - \theta_3\ln(YPC)_{i,t-1} - \theta_4\ln(MUI)_{i,t-1}$.

A significant and negative value of ϕ implies the existence of long-run relationship or cointegration. The PMG restriction is that the elements of long-run coefficients are common across countries. To calculate the shadow economy, we follow Tanzi (1983) and other studies in several steps. First, we calculate the predicted value of currency ratio, expressed as $Z_{it}^* = \ln\left(\frac{C}{M2}\right)_{it}^*$ using Equation (7). The second step involves calculating the predicted value of currency ratio by setting the tax rate at zero, whilst the estimated coefficients for other variables remain unchanged, denoted as $Z_{it} = \ln\left(\frac{C}{M2}\right)_{it}$. Third, the difference between C_{it}^* and C_{it} shows an estimate of illegal stock money (stock of currency held for the purpose of tax evasion). Fourth, the illegal stock money is multiplied by the velocity of money, to yield an estimate of shadow economy. It is assumed that velocity of illegal stock money is equal to the velocity of legal money. Lastly, the shadow economy as a percentage of the official economy (% of GDP) is expressed for the purpose of comparison, by computing the amount of shadow economy divided by GDP.

3.1. *Data and descriptions of variables*

The data are at annual frequency, consisting of 80 countries for the period 1975 - 2012. According to the World Bank country classification, these countries are classified as East Asia and Pacific (EAP), Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), Middle East and North, Africa (MENA), South Asia (SAS), Sub-Saharan Africa (SSA), high income OECD, high income non-OECD, and euro area (EURO) regions[5]. The length and width of panel is constrained by the lack of available data on variables capturing tax burden. In addition, the constructed panel data set has been left unbalanced in order to increase the sample size. Data for currency in circulation, and M2 are drawn from Asian Development Bank's (ADB) Website (http://www.adb.org) and International Financial Statistics (IFS) 2013 CD-Rom. Data for tax revenue is collected from ADB, World Bank's World Development Indicators (WDI), Government Finance Statistics (GFS) 2014 CD-Rom. Due to issue of data unavailability, in some instance, we use different measures of interest rates from different sources including deposit rate and money market rate (IFS) and discount rate (Datastream). Other data such as income per capita, inflation rate and exchange rate are collected from World Bank's World Development Indicators (WDI). In Appendix A, we outline the countries and their sample

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[5] We extract the Eurozone, the official euro area, from high income OECD and high income non-OECD regions. The reason that the euro area is an economic and monetary union (EMU) consisting of 19 European Union (EU) member states which have adopted their single currency namely euro currency. It currently consists of Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Malta, Netherlands, Portugal, Slovak Republic, Slovenia and Spain. The information is obtained from https://www.ecb.europa.eu/euro/intro/html/map.en.html.

periods in the panel and Appendix B contains detailed descriptions of each variable and data source used in this study.

4.   RESULTS AND DISCUSSIONS

4.1.   *Panel unit root tests*

Prior to the estimations, we evaluate the integration properties of all the variables used in the analysis. The panel unit root tests employed are widely used first generation panel unit root tests allowing for an unbalanced panel dataset (Im, Pesaran, & Shin, 2003; Maddala & Wu, 1999). All the tests are based on the null of a unit root. We find strong evidence that most variables are clearly I(*1*) if a length of two or more lags are used. The only exception is the macroeconomic economic uncertainty (LnMUI) which is found to be stationary at levels for all regions. This is because LnMUI is constructed using the dynamic factor model (DFM) that requires its variables to be stationary at the first place. Study by Elbadawi, Kaltani and Schmidt-Hebbel (2008) confirmed that all variables examined are stationary if they are formulated as index numbers, trend deviations, or shares. Overall, these results suggest most conservatively that all series in levels are nonstationary I(*1*) except LnMUI which is found to be I(*0*). Therefore, it may worth noting that none of the variables examined are I(*2*) or higher level of integration[6].

4.2.   *Pooled mean group (PMG) estimator*

Table 2 reports the estimation results for the PMG estimator. PMG estimator is based on an autoregressive distributed lag (ARDL) model which does not require the variables to be I(*1*) and still valid whether variables of interest are I(*0*) and I(*1*). Hence, the PMG estimator avoids the need of pretesting for unit root. Furthermore, the PMG estimates will be more consistent and efficient under several specification conditions. First condition is related to the residuals of the error-correction model. The preferred ARDL models are augmented with more lags to ensure that the regression residuals are serially uncorrelated and in turn, the independent variables can be treated as exogenous. In doing so, we choose the lag length criteria using AIC and SBC while the maximum lag order of the ARDL model is set for three for each country.

The second condition requires the adjustment coefficients to be negative and within the unit circle, which implies that there exists a long-run relationship (dynamic stability). As shown in Table 2, all the error-correction coefficients are significantly negative and fall within the dynamically stable range, revealing that the dynamic stability condition holds. Hence, this can be treated as evidence in supporting for cointegration relationship that indeed exists among the variables[7]. In terms of the adjustment coefficients (which is measured in absolute values), there is considerable cross regional variation, with EAP having the lowest of 0.182 and SSA, the highest of 0.414. Meanwhile, the average speed of adjustment coefficients for high income OECD, high income non-OECD, and EURO

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[6] To conserve space the results for panel unit root tests are available from the authors upon request.

[7] The null hypothesis of non-cointegration can be tested using the error-correction *t*-statistics. If the null is not rejected, we conclude that there is no cointegration between variables (or *vice versa*).

Table 2: Pooled Mean Group (PMG) estimates

	(1) EAP	(2) ECA	(3) LAC	(4) MENA	(5) SAS	(6) SSA	(7) High Income OECD	(8) High Income Non-OECD	(9) EURO
Long-run coefficients:									
$LnTAX_t$	0.288* (1.824)	0.268*** (2.794)	0.331** (2.455)	0.187 (1.224)	0.224 (1.583)	0.158** (1.980)	0.874*** (12.026)	0.477*** (-7.225)	0.492 (-1.357)
LnR_t	-0.117*** (-3.573)	-0.118*** (-5.286)	-0.039 (-1.344)	-0.036 (-0.918)	-0.376*** (-3.217)	-0.347*** (-6.705)	-0.306*** (-9.119)	-0.214*** (-9.851)	-0.314*** (-11.869)
$LnYPC_t$	-0.517*** (-10.504)	-0.659*** (-7.845)	-1.105*** (-8.462)	-0.315*** (-2.672)	-0.616*** (-6.794)	-0.469*** (-2.628)	-0.824*** (-9.493)	-1.021*** (-11.594)	-0.264 (-1.537)
$LnMUI_t$	2.711*** (3.570)	1.480** (2.205)	11.832*** (5.192)	0.011 (0.020)	1.292*** (2.132)	2.928*** (2.207)	1.359* (1.634)	0.409 (0.572)	2.082*** (7.676)
Error correction	-0.182*** (-3.112)	-0.365** (-2.368)	-0.237* (-1.668)	-0.237* (-1.755)	-0.322*** (-4.704)	-0.414*** (-3.113)	-0.197* (-1.810)	-0.271** (-2.090)	-0.352** (-2.115)
Short-run coefficients:									
$\Delta LnTAX_t$	0.078 (0.822)	0.011 (0.039)	0.182 (0.845)	-0.439* (-1.856)	-0.103 (-0.757)	-0.386 (-0.947)	0.038 (0.271)	-0.088 (-1.060)	-0.169 (-0.542)
$\Delta LnTAX_{t-1}$		0.102 (0.893)		0.403* (1.647)	0.010 (0.094)				
$\Delta LnTAX_{t-2}$				-0.100 (-1.101)	-0.010 (-0.240)				
ΔLnR_t	-0.046 (-1.516)	0.033 (0.949)	-0.169 (-1.493)	0.06 (0.515)	0.075** (2.505)	-0.241 (-0.641)	-0.046 (-1.576)	-0.054 (-1.242)	0.096 (1.095)
ΔLnR_{t-1}			0.353 (1.340)	0.066 (0.463)				0.006 (0.190)	0.091* (1.907)
ΔLnR_{t-2}			-0.171 (-1.293)						
$\Delta LnYPC_t$	-0.659 (-1.394)	0.261 (0.659)	1.147 (0.875)	-0.645 (-1.252)	0.331 (1.092)	-2.16 (-0.865)	0.399 (1.396)	0.31 (1.299)	-0.918* (-1.840)
$\Delta LnYPC_{t-1}$	0.663 (-1.517)		-0.420 (-0.238)			1.531			
$\Delta LnYPC_{t-2}$			0.188 (0.244)			-0.909			
$\Delta LnMUI_t$	0.878 (0.743)	-7.172* (-1.802)	5.659 (1.320)	-0.311 (-0.243)	-17.635 (-1.022)	-0.953 (-0.168)	-1.005 (-0.420)	-25.175* (-1.685)	-0.467 (-1.043)
$\Delta LnMUI_{t-1}$			-0.487 (-0.200)	0.661 (0.701)	24.138 (1.238)		1.437 (1.441)	6.974** (2.056)	
$\Delta LnMUI_{t-2}$					-5.99 (-0.934)				
Constant	-0.177*** (-2.743)	0.706** (1.996)	-0.627 (-1.631)	0.087** (2.207)	0.494*** (3.723)	-0.009 (-0.113)	0.465* (1.691)	1.543** (2.105)	-1.012* (-1.712)
Observations	283	123	179	102	120	173	328	156	318
Number of countries	11	8	9	6	5	11	11	8	11
Time period	1982-2012	1992-2012	1988-2012	1990-2012	1986-2012	1990-2012	1976-2012	1988-2012	1975-2012
Log likelihood	357.489	179.94	290.922	244.72	217.013	262.333	465.741	258.778	248.881
AIC	-517.352	-138.008	-264.213	-290.005	-286.104	-264.911	-600.423	-363.932	-176.236
SBC	-477.252	-107.074	-216.402	-253.255	-247.079	-230.225	-558.7	-327.333	-134.853
Hausman test (χ^2)	2.340	1.830	0.500	2.930	2.680	0.460	5.690	1.130	6.280
p-value	0.674	0.768	0.974	0.5690	0.613	0.977	0.224	0.889	0.180

Note: Asterisks, ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Figures in parentheses are z-statistics except figures in parentheses for Hausman test are p-values. AIC and SBC have been used to select the lag orders for each group. All the long-run parameters have been restricted to be the same across group[8].

[8] According to Pesaran et al. (1999), the PMG estimates are more preferable to the MG estimates in terms of their better precision and less sensitive to outlier estimates. Moreover, numerous dynamic panel data studies have focused on the magnitude of large T and small N. Like previous studies such as Asteriou (2009) (N=5; T=1975-2002), Camarero (2008) (different N ranging from 5 to 12; T=1970-1998), Das and Chowdhury (2011) (N=11; T=1985-2009), Pesaran et al., (1999) (a. N=24; T=1962-1993, b. N=10; T=1974-1990), and Santana-Gallego, Ledesma-Rodríguez, and Pérez-Rodríguez, (2011) (N=5; T=1980-2006). Similarly, we also focus on relatively smaller N, ranging from 6 to 11 with moderate to large T in this study.

regions are 0.197, 0.271, and 0.352, respectively. There are some noteworthy differences across nine regions; in some instances adjustment is considerably slow. For example, SSA region appears somehow faster while EAP shows relatively slower adjustment process. These slow adjustments support the view of Wong (1977) on money demand that the speed of adjustment to equilibrium in LDCs may be slow if most wealth holders are risk averters. The slowness could arise due to risk averters are more conservative in adjusting their portfolios when confronted with higher risks and uncertainties. In addition, the half-life of deviations from equilibrium is about two to four years range. The third condition refers to the long-run coefficients are identical across countries. As regards to the PMG and MG estimations, the Hausman tests indicate that imposing long-run homogeneity cannot be rejected at the conventional significance levels in all regions. For that reason, the PMG estimation is the appropriate ones for subsequent interpretations. Therefore, the rest of the study relies on the PMG estimator.

The long–run parameter estimates can be discussed as follows. In line with the economic expectation, the estimated coefficients of all the long-run models from column (1) to column (9) have the expected signs. The long-run coefficients of the average tax rate (LnTAX) are positive and significant in most regions except MENA, SAS, and EURO, signifying that economic agents who wish to avoid taxes tend to use more currency. Thus, rising tax burden discourage work and push more people into the shadow economy. In addition, the significant and negative long-run parameter estimates on income per capita (LnYPC) in all countries, suggesting that greater economic prosperity lowers currency demand. Perhaps as people get richer they attempt to evade less. As for the long-run effects of other determinants, the coefficients of the real interest rate (LnR) carry negative sign and highly significant at least at the 5% levels in most regions except LAC and MENA. This is consistent with the evidence of the previous studies that interest rate equals the opportunity cost of holding currency (Alm & Embaye, 2013; Ardizzi et al., 2014; Bagachwa & Naho, 1995; Hill & Kabir, 2000). A rise in interest rate leads to an increase in the opportunity cost of holding currency causing people to demand less currency holding.

Turning back to the initial motivation of the study, our main concern is the introduction of macroeconomic uncertainty index (LnMUI) in the CDA model. It is clear that macroeconomic uncertainty index carries a positive and significant coefficient in all regions with the exception of MENA and high income non-OECD regions, implying that indeed a worsening macroeconomic environment has a positive long-run effect on the currency demand in all regions. This is because economic agents might take a precautionary action towards more safer and liquid assets and hence lead to a rise in the currency ratio. These significant and positive estimates are similar to several studies on the demand for money such as Arize (1987), Atta-Mensah (2004), Bahmani-Oskooee et al. (2013), Bahmani-Oskooee and Xi (2011), Choi and Oh (2003), and Greiber and Lemke (2005). On the other hand, uncertain macroeconomic condition causes a greater nervousness and anxiety that may make agents to reduce trust level through distorting their ability of paying taxes and hence increase the shadow economic activities.

Lastly, the PMG estimator allows the short-run coefficients to be different across countries. However, the contemporaneous changes tell an entirely different story, where all the short-run coefficients for average tax rate (LnTAX), real interest rate (LnR),

income per capita (LnYPC), and macroeconomic uncertainty index (LnMUI) appears to be insignificant. This shows that in the short-run these coefficients are not important determinants of currency ratio, suggesting all determinants have more permanent effects (movements) than transitory effects in all regions over the sample period.

4.3. The size of the shadow economies

We estimate the size of the shadow economy for 80 countries over the period 1975-2012 using the estimated results from Table 2 combined with the procedures we discussed earlier. However, the PMG estimator involves the testing for cointegration using the standard ARDL model for panels which requires different lag orders. Therefore, we consider the time period 1978-2012 and the complete dataset containing a list of the shadow economy estimates for 80 countries is reported in Appendix C.

Table 3 presents these estimates with the purpose of observing the variation of the size of the shadow economy according to different regions. We observe that developing regions (ranging from 19.9% to 37.3%) exhibit relatively larger size of the shadow economy. In particular, ECA and MENA have reached a sizeable figure of the shadow economy, 37.3% and 31.3%, respectively. The estimates are closely followed by EAP (27.4%), SAS (23.7%), SSA (22.5%), and LAC (19.9%). On the other hand, developed regions have a considerable smaller estimate (ranging from 13.7% to 19.0%) where the shadow economy estimates for EURO (13.7%) are still small in comparison to both high income OECD and high income non-OECD countries (19.0%). In terms of the standard deviations, there is a wide difference between regions. Overall, the world estimates of the shadow economy as a percentage of GDP, on average, is about 23.1% (standard deviation of 13.5%).

Table 3: Descriptive statistics for shadow economy (% of GDP)

	Mean	Std. Dev.	Median	Min	Max
EAP	27.4	14.9	24.9	14.0	66.0
ECA	37.3	19.6	29.0	12.9	69.6
LAC	19.9	5.5	16.9	15.3	31.2
MENA	31.3	18.1	23.3	16.6	63.1
SAS	23.7	13.9	23.1	11.3	44.9
SSA	22.5	6.4	19.5	16.3	37.2
High Income OECD	19.0	12.9	16.4	6.7	48.6
High Income Non-OECD	19.0	10.9	16.7	5.9	36.0
EURO	13.7	6.7	12.0	6.2	30.2
World	23.1	13.5	19.0	5.9	69.6

Source: Authors' own calculations

Next Figure 1 illustrates the development of the size of the shadow economy by different regions over time. The upper panel of the figure shows the evolution of the shadow economy for developing regions, while the evolution of the estimates in the developed regions is given in the lower panel. As observed, the shadow economy estimates have been fluctuating around 15-40% for most developing regions except EAP, ECA, and LAC. Nevertheless, EAP and LAC seem to have a slightly declining trend over the entire sample period. On the contrary, we observe that the shadow economy in ECA skyrocketed to reach its peak point in 1998 with more than 50% of economic activities are

underground, and it remain quite stable in subsequent two years before declining. Developed regions (lower panel), on the other hand, have experienced significant changes over the sample period. Initially, we observe an upward trend during the period 1978-1997, followed by a dramatic decline between 1998 and 2007, and starts climbing from 2008 onwards.

Figure 1: Trend of shadow economy (% of GDP) over time by regions
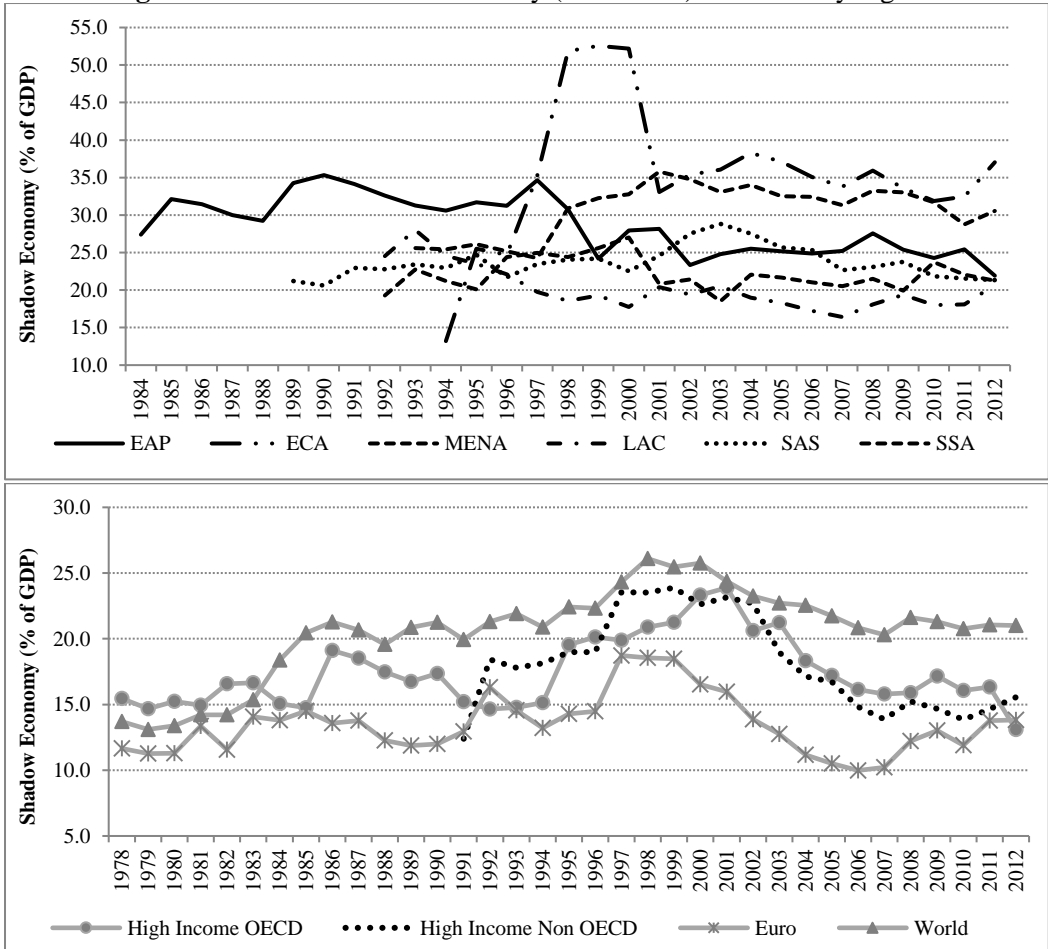
Source: Authors' own computation.

Lastly, Figure 2 demonstrates how large the variation in the size of the shadow economy as a portion of GDP. The top position is largely occupied by most of the developing countries such as Thailand, Kyrgyz Republic, Egypt, Moldova, Jordan, Bangladesh and Republic of Korea. These countries have a relatively large share of the shadow economy between 41-70% (of GDP), showing that the shadow economy is more than half the size of the official economy. Notice that the advanced countries are located at the bottom of the figure, with an average of about 5-15% (of GDP). These countries include Bahrain,

Figure 2: Distribution of the size of the shadow economy (% of GDP)
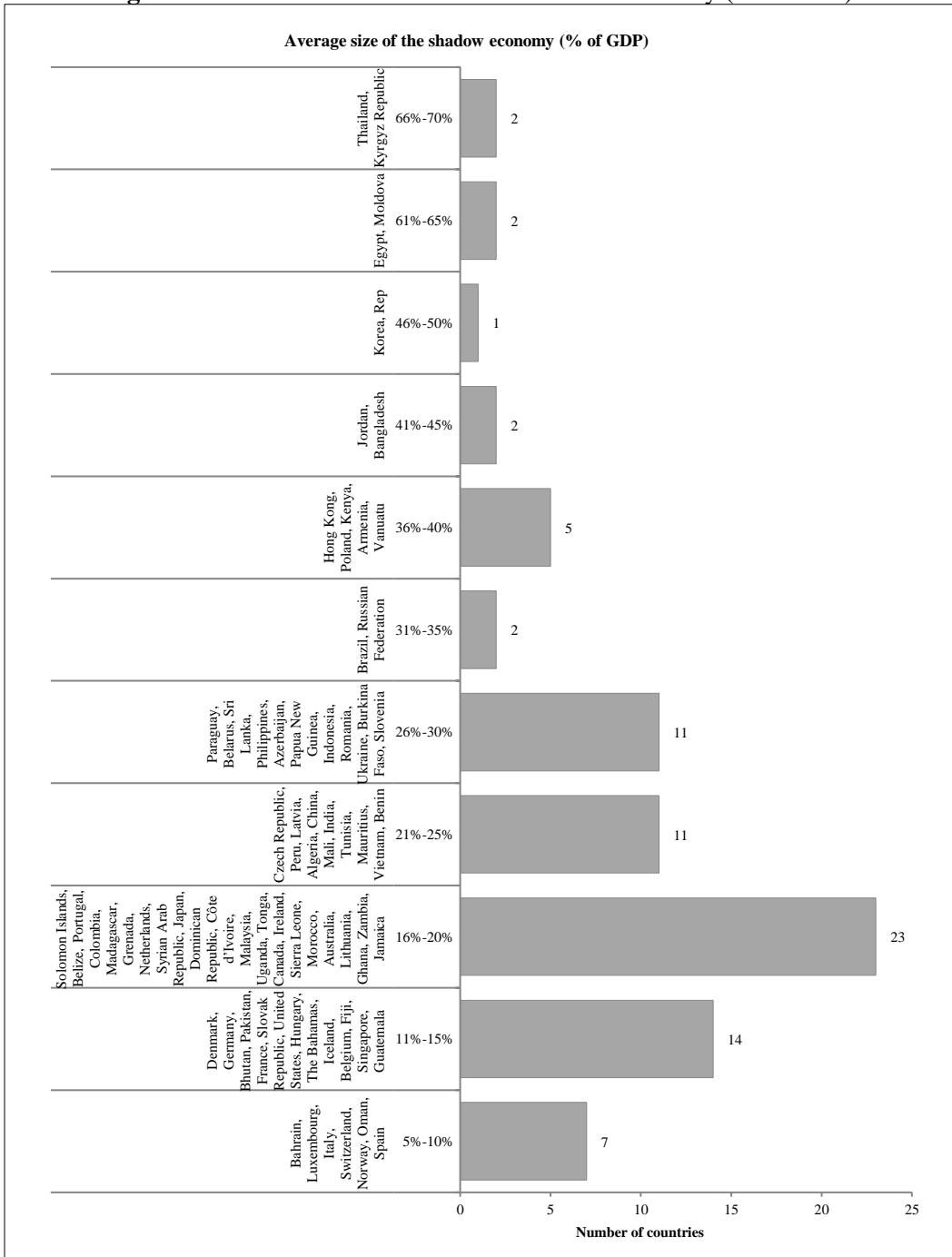
Luxembourg, Italy, Switzerland, Norway, Oman, Spain, Denmark, Germany, Bhutan, Pakistan, France, Slovak Republic, United States, Hungary, The Bahamas, Iceland, Belgium, Fiji, Singapore, and Guatemala. Overall, we find that most countries are situated in the middle where average shadow economies lie between 16%-20% (of GDP). These countries are Solomon Islands, Belize, Portugal, Colombia, Madagascar, Grenada, Netherlands, Syrian Arab Republic, Japan, Dominican Republic, Côte d'Ivoire, Malaysia, Uganda, Tonga, Canada, Ireland, Sierra Leone, Morocco, Australia, Lithuania, Ghana, Zambia, and Jamaica.

5.   CONCLUSION

There are a large number of cash transactions that are typically taking place outside the control of the government authorities every year. In most general form, these activities are known as shadow economy. The existence of the shadow economy tends to misrepresent the true size of a country's economy. Therefore, the aim of this study is to estimate the size of the shadow economy for 80 countries from nine regions over the period 1975-2012 using the currency demand approach. In this study, we go beyond the existing studies by introducing a measure of macroeconomic uncertainty index (MUI) in the standard CDA model. Second, we model the MUI for each country by means of dynamic factor model (DFM). Third, the PMG estimator allows capturing the heterogeneity across countries in the short-run dynamics but imposing restrictions in the long-run parameters. Once such an estimation results are specified, we use the resulting parameters to compute the size of the shadow economy for 80 countries. Thus, our study allows heterogeneity across countries by estimating a sub-regional panel data setting as compared to a large panel setting as was done by Alm & Embaye (2013), Elgin & Oztunali (2012), Schneider et al. (2010) and Schneider (2007)[9],

The empirical findings indicate the existence of long-run relationship among variables examined. In terms of the adjustment coefficients (which is measured in absolute values), there is considerable cross regional variation, with the lowest of 0.182 and the highest of 0.414. This suggests that on average approximately 18.2% to 41.4% of the deviations of currency ratio from the long-run equilibrium are corrected during one year. In addition, most long-run coefficients are statistically significant and have the expected signs. We find that in the long-run, an increase of the tax rate can increase the use of currency ratio. In contrast, higher interest rate tends to lower the currency demand by increasing the opportunity cost of holding currency. Similarly, high levels of economic activity leading to a significantly lower currency ratio. Turning to our variable of interest, the currency demand is positively influenced by macroeconomic uncertainty. Such an uncertain macroeconomic environment tends to encourage people to hold more currency.

Subsequently, the estimated long-run coefficients of the CDA equations are adopted to calculate the size of the shadow economy. We observe that developing regions (ranging

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[9] Schneider et al. (2010) and Elgin and Oztunali (2012) have constructed the world's largest dataset on 162 and 161 countries, respectively. However, the former has covered a relatively short period of time from 1999-2007, while the latter on an unbalanced dataset from 1950-2009. On the other hand, Alm & Embaye (2013) estimate unbalanced panel of 111 countries together with a long time period from 1984-2006.

from 19.9% to 37.3%) exhibit relatively larger size of the shadow economy. Alternatively, developed regions have a considerable smaller estimate (ranging from 13.7% to 19.0%) where the shadow economy estimates for Euro area (13.7%) are still small in comparison to both high income OECD and high income non OECD countries (19.0%). Additionally, it is noticed that the size of the shadow economy has fluctuated substantially in most regions over the sample period. For the initial period, there has been an upward trend in the shadow economy; however, it falls continuously until 2007-2008 before increasing again. On average, the estimated world shadow economy as a percentage of GDP is about 23.1%.

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APPENDICES

Appendix A: Lists of countries by regions

Regions	Countries
EAP	China, Fiji, Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Is, Thailand, Tonga, Vanuatu, Vietnam
ECA	Armenia, Azerbaijan, Belarus, Hungary, Kyrgyz Rep, Moldova, Romania, Ukraine
LAC	Belize, Brazil, Colombia, Dominican Rep, Grenada, Guatemala, Jamaica, Paraguay, Peru
MENA	Algeria, Egypt, Jordan, Morocco, Syria, Tunisia
SAS	Bangladesh, Bhutan, India, Pakistan, Sri Lanka
SSA	Benin, Burkina Faso, Cote d'Ivoire, Ghana, Kenya, Madagascar, Mali, Mauritius, Sierra Leone, Uganda, Zambia
High income OECD	Australia, Canada, Czech Rep, Denmark, Iceland, Japan, South Korea, Norway, Poland, Switzerland, United States
High income non-OECD	Bahamas, Bahrain, Hong Kong, Latvia, Lithuania, Oman, Russian Fed, Singapore
EURO	Belgium, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovak Rep, Slovenia, Spain

Appendix B: Variable descriptions and data sources

Variables	Description/Definition	Sources
C/M2	Ratio of currency in circulation to M2. Currency in circulation comprises currency with the public, refers specifically to coins and notes outside the banking system, and M2 comprises money and quasi money.	Currency in circulation, M1 and M2 are drawn from Asian Development Bank (ADB) and International Financial Statistics (IFS). M1 is used to calculate the velocity.
TAX	Total tax revenues divided by GDP (annual %).	Total tax revenues are from ADB, World Bank, and Government Finance Statistics (GFS) whereas GDP is collected from World Bank.
R	Real interest rate from different measures include deposit rate, money market rate, money market rate (annual %); inflation rate measured by GDP deflator (annual %).	Deposit rate and money market rate (IFS); Discount rate (Datastream).
YPC	GDP per capita at constant 2005 (US$).	World Bank.
MUI	Macroeconomic uncertainty index is constructed based five main macroeconomic indicators namely total tax revenue to GDP ratio, different measures of interest rate include deposit rate, money market rate, money market rate (annual %), GDP per capita at constant 2005 (US$), inflation rate measured by GDP deflator (annual %), and exchange rate.	Nearly all of the variables listed as in above sources except inflation rate is obtained from World Bank.

Appendix C: Shadow economy (% of GDP) estimates by country (con't)

No.	Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	Algeria																			
2	Armenia																			
3	Australia	21.5	17.7	17.8	19.5	22.7	23.9	17.5	23	25.7	25	22.1	20.9	27.3	22.8	17.1	14.1	17.2	19.1	21.2
4	Azerbaijan																			
5	Bahamas, The														10	12.2	15.1	16.5	16.7	16.2
6	Bahrain														7.3	7.2	6.8	7.5	7.2	7.7
7	Bangladesh												36		36.7	39.2	46.7	47	52.2	41.4
8	Belarus													34.6					35.5	29.5
9	Belgium	12.8	12.5	10.7	13.4	8.9	7.2	5.9	7.2	7.7	9.5	10.4	13.2	13.4	15.3	21.3	20.2	12.9	17.9	24.3
10	Belize															17.3	20	20.1	24.6	28.9
11	Benin																			
12	Bhutan												10.7	10.3	10.4	9.7	13.6	12.5	13.4	9.1
13	Brazil																	21.7	30.3	31.1
14	Burkina Faso																			
15	Canada	21.2	22.8	24	24.7	25.1	24.4	18.6	13.9	13.9	15.8	15.1	15.3	15.9	19.2	21.4	20	17.1	15.1	17
16	China							25.3	38.4	37.4	36.1	29.8	28.6	31.8	31.2	26.5	22.4	20.7	25.8	23.6
17	Colombia															15.5	17.4	16.5	15.8	17
18	Côte d'Ivoire																		19.1	19.5
19	Czech Republic																			24.6
20	Denmark	11.7	12.1	11.2	11.6	11.6	13.1	13.3	13	13.4	11.6	11.1	10.3	9.2	8.8	8.2	9.1	9.4	9.5	10.2
21	Dominican Republic																	16.1	14.4	12.8
22	Egypt, Arab Rep.																			
23	Fiji																		20.8	16.4
24	France	10.8	9.4	5.8	8.6	6.1	9.7	8.6	9.3	10.4	9.6	8.2	8.1	6.6	8.4	8.1	9.6	12.8	11.4	13.2
25	Germany	15.8	13.4	13.1	14.7	15.3	15.8	14	13.6	13.4	15.1	11.7	10.2	8.7	9.4	9.3	11.3	11.4	10.6	9.6
26	Ghana																			
27	Grenada															16.2	24.6	29.3	26	24.9
28	Guatemala																21.1	16.2	16.6	14.5
29	Hong Kong, China														41.1		39.7	38	37.6	41.4
30	Hungary																	13.2	15.6	15.7
31	Iceland	15.2	14.6	14	11	15.6	16.8	16	13.9	13.2	9.6	15	15.6	17	15.3	17.3	19.1	21.4	18.7	18.5
32	India												27.6	26.9	26.1	28.9	21.5	21.2	21.1	20.1
33	Indonesia							18.9	21.3	20.1	24.7	23.9	25.4	34.4	32.4	34.4	34	33.3	34.5	26.4
34	Ireland						25.2	19.5	20.4	16.6	19.7	18.6	13.9	14.3	14.2	38.9	20.2	21.3	17.4	18.8
35	Italy	5.7	4.8	4.8	4.8	5.2	5.6	5.5	5.5	6	5.8	5.9	5.9	6.3	6.3	6.7	7.8	7.7	6.8	6.9

Appendix C: Shadow economy (% of GDP) estimates by country (con't)

No.	Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Country Average
1	Algeria	21.6	18.8	20.7	22.7	28.8	29.7	27.9	22.2	23.6	23.3	20	21.4	18.9	18.9	18.6		22.5
2	Armenia		45.2	58.8	55.2	48.3	35.5	37.4	43	29.6	23.8	20.3	25.3	35.9	35.5	36.1	41	38.1
3	Australia	20.1	19.6	19.8	18.3	21.4	14.9	15.4	16.2	16	16.1	14.4	14.7	14.9	10.6	12.4	13.4	18.7
4	Azerbaijan						47.5	44.2	49.6	43.3	27	20.7	18.8	14.9	13.5	13.8	13.3	27.9
5	Bahamas, The	15.4	12.4	11.6	12	12.4	11.3	11.3	10.8	11	12.2	13.4	15.5	16.3	16	17.8	16.4	13.7
6	Bahrain	8.1	9.7	7.9	6.8	7	6.7	5.2	6.2	5.7	4.1	2	2.5	2.6	2.5	2.3		5.9
7	Bangladesh	43.6	44.6	43.6	41.1	46.8	50.3	56.2	57.4	52.7	47	43.9	42.3	47	44.3	40.9	43.1	44.9
8	Belarus	30.7	47.9	35.8	51.4	17.7	17	20.1	21.6	21	21.1	23.3	23.5	23.2	22.1	24.3	23.2	27.2
9	Belgium	23	22.6	17.8	17.4	19.3	15.7	15.1	12.8	15.6	13.3	12.7	14.2	12.6	5.6			14
10	Belize	28.5	21.3	17.4	12.2	11.9	12.3	10.3	8.5	10.9	11.6	13.2	15.2	14.2	12	11.9	11.5	15.9
11	Benin						21.2	22	26.8	24.8	24.2	25.4	26.4	26.9	26.5	25.6	28.2	25.3
12	Bhutan	13.2	13.1	10.9	14.4	11.4	10.8	12.8	10.6	11.1	12.6	8.8	11.2	11.3	12.9	8.7	7.8	11.3
13	Brazil	23.4	27.5	34.4	35.5	34.2	29.9	35.8	35.2	33.5	32.3	25.5	29.1	30	32.2	34.1	37.7	31.2
14	Burkina Faso							23.4	29.8	28.4	29	28.7	30.2	30.4	32.7	31.9	34.2	29.9
15	Canada	18.5	15.3	14.2	13.2	17.8	19.1	17.1	17.7	18.1	15.4	12.1	11.2					17.8
16	China	21.3	21.2	20.9	19.6	20.6	19.9	18.9	18.1	18.1	16.7	14.5	15.8	13.5	12.9	13.7	14.4	22.7
17	Colombia	18.3	21.1	21	15.3	17.8	16.7	15.8	15.5	15.7	12	16.6	15.4	15.4	13.8	13.3		16.3
18	Côte d'Ivoire	18.6	16.6	15.2	15.3	14.7	15.5	17.2	16.5	17.1	17.3	16.7	18.2	17.4	18.2	15.5	16.3	16.9
19	Czech Republic	25.7	27.4	29.8	34.1	35.4	19.8	19.8	19.5	17.2	15.7	15.6	14.3	13.6	12.3	12.5	12.8	20.6
20	Denmark	10.3	9.7	9.3	6.8	8.2	9.4	10.7	10	8.5	7.5	8	9.3	13	13.5	12.4	13.5	10.5
21	Dominican Republic	14.2	14.1	13.6	16.6	26.8	24.4	23.8	20.6	16.1	18	15.4	16.2	13.3	13.7	13.8		16.9
22	Egypt, Arab Rep.		65.3	66.2	69.7	74.8	70.2	67.9	76.2	69.5	71	62.3	59	56.3	50.7	44.9	41.8	63.1
23	Fiji	17	13.1	10.8	14.7	12.3	15.3	15.1	13.7	13.7	15.1	11	12.8	14.9	12.5	11.2	12.3	14
24	France	14.2	14.5	15.8	12.7	11.7	16.2	14.6	15.1	13.1	11.2	10.1	13.3	17.5	17.9	16.4	18.4	11.6
25	Germany	8.8	7.9	10.8	9	8.1	8.5	9	8.5	7.8	6.9	7	8.7	8.6	7.9	7.9	7.3	10.5
26	Ghana						14.4	16.6	17	19.9	19.5	17.2	15.3	13.3	46.4	15.3		19.5
27	Grenada	22.8	19.1	16.4	13.4	12.7	14.9	11.1	7.5	9.7	7.5	10.6	10.1	12.9	19.8	18.2	16.5	16.4
28	Guatemala	13.4	14	14.3	11.8	15.6	10.7	17.8	16.3	17	16.1	14.5	15.5	16.9	13.2	14.2	15.4	15.3
29	Hong Kong, China	45.3	47.9	46.9	44.7	47.1	46.1	37.5	34.7	32.8	27.3	27.3	30.7	24	22.6	22.9	19.8	36
30	Hungary	14.1	13.6	13.5	14	13.5	12.9	11.9	12.1	10.9	10	10.6	12.4	14.4	12.8	11.8	12.2	12.9
31	Iceland	15	13.9	13.4	13	14	14.9	14.1	10.6	12	15.9	7.7	6.3	6.7	8.6	9.3	9.5	13.8
32	India	21.7	20.4	23.4	20.7	21.7	23.3	22.7	22.6	21.9	22.4	24.1	24.3	23.2	22.3	24.3	21.6	23.1
33	Indonesia	27.4	35	16.7	38.8	36	28.1	31.3	33.7	33	24.7	23.7	29.1	23.3	23.1	24.8	22.9	28.1
34	Ireland	33.5	29.7	31.6	24.5	22.8	25.6	10.6	10.6	9.9	8.9	8.6	10.7	8.7	7.9	9	9.9	18
35	Italy	6.8	6.8	6.5	5.4	5.6	5.8	5.9	5.8	5.5	5.2	6	6.9	8.2	10	9.7	11.5	6.4

Appendix C: Shadow economy (% of GDP) estimates by country (con't)

No.	Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
36	Jamaica																			4.2
37	Japan	19.6	17.5	19.2	19.7	20.4	22.4	22.4	22.3	27.5	29.9	28.6	28.6	24.4	21	20.6	22.1	21.5	21	21.7
38	Jordan																33.9	33.9	36.7	44.4
39	Kenya																			44.9
40	Korea, Rep.									49.6	46.8	42	38.1	41	29.5	29	28.3	29.4	26.4	31.3
41	Kyrgyz Republic																			
42	Latvia																			
43	Lithuania																		24.7	20.7
44	Luxembourg																			
45	Madagascar															11.1	13.1	13.7	14.8	13.7
46	Malaysia							18.9	21.9	19.7	16.8	17.5	17.5	17.5	17.6	18	14.7	15.7	16.1	16.1
47	Mali																			
48	Mauritius															27.3	36.7	28.9	26.9	31.2
49	Moldova																			
50	Morocco																			16.6
51	Netherlands			20.4	24.4	16.8	16.1	18.5	20.2	20.4	21.2	20.3	21.3	24.3	26.2	22.7	19.2	15.1	13.4	13.6
52	Norway			19	17.4	17.6	17.1	15.3	11.7	10.1	7.5	6.4	5.7	5.6	4.9	3.9	4.5	4.5	4.6	4.6
53	Oman														13.5	12.3	11.6	13.2	13.3	13.4
54	Pakistan												13.4	12.2	13.1	14.2	14.4	12.7	12.3	12.9
55	Papua New Guinea							29.2	31.7	35.1	33.7	32.7	36.3	36.2	27.8	29.1	33.8	30.4	28.9	27.9
56	Paraguay																48.1	42	32.3	33.2
57	Peru															49.2	37	34.5	28.1	32.4
58	Philippines							21.5	34.4	31.8	24.9	22.6	21.6	22.9	27.1	32.5	34.4	38.8	38	34.8
59	Poland																		63.1	54.2
60	Portugal	10	11.9	13.5	17.9	19	23	27.7	28.4	21.7	17.3	13.9	13.5	13.9	14.1	13.2	15.9	16.5	15.2	14
61	Romania																		25.4	29
62	Russian Federation																			
63	Sierra Leone																			
64	Singapore														18.7	19.4	24.8	22.4	20.6	19.3
65	Slovak Republic															19.2	15.9	15.6	14.4	14.5
66	Slovenia																	9.5	24.3	17.1
67	Solomon Islands															13.8	15.5	14.2	13.3	13.5
68	Spain	14.8	15.6	10.6	9.9	9.6	10.1	10.6	11.5	12.4	12.1	9.1	8.9	8.4	9.4	10.2	12.1	11.9	11.5	12.9
69	Sri Lanka												18.3	18.9	28.5	21.9	20.9	21.3	24.7	25
70	Switzerland	6.2	5.9	5	5.2	7	6.2	6.4	7.2	7.4	9.1	6.3	5.2	5.4	5.8	6	6.7	7.4	8.7	8.1

Appendix C: Shadow economy (% of GDP) estimates by country (con't)

No.	Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Country Average
36	Jamaica	4.5	5.1	4.7	8.9	13.4	19.2	25.2	25.7	24	23.9	24	28.3	37.6	29.2	27.9	34.6	20
37	Japan	18.2	17.2	15.9	16.4	12.1	9.1	7.4	7.3	7	6.5	6	5.8	5.9	5.7	6	6	16.7
38	Jordan	41.9	45.2	48.3	45.6	47.7	45.7	43	45.7	44.7	43.3	45.5	39.8	46.5	45.6	39.2	38.9	42.8
39	Kenya	38.4	27.2	42.2	42.6	28.8	38.9	29.3	43.8	40.1	39.6	37.8	40.3	27.7	30.5	42.7		37.2
40	Korea, Rep.	35.5	47.9	57.5	80	80.7	68.8	78.6	65.9	57.1	47.6	47.5	48.8	53.9	52.2	50.3		48.6
41	Kyrgyz Republic	52.8	71.4	66	68.8	62.8	72.2	69.3	72.7	74.1	78.6	71.8	76.8	70.8	68	64.4	72.8	69.6
42	Latvia	36.8	35.9	32.4	30.5	27.2	27.4	18.5	16.2	15.4	13	12.8	14.5	16.7	18.2	17.3	15.6	21.8
43	Lithuania	21.3	19.9	23.2	24	23.1	28	23.4	17.7	14	13.3	11.4	12.4	15.7	15.2			19.3
44	Luxembourg					6	5.9	6.3	6.6	6.6	7.2	6.3	6	6.8	5.4	5.8	5.5	6.2
45	Madagascar	15.1	18.5	15.3	16	15	15.1	14.8	18.2	15.8	15	17.5	22.1	20.5	20.5	20.2		16.3
46	Malaysia	19	21.5	14.6	14.6	19.3	15.4	15	16.8	18.1	17.9	15.3	16.4	17.4	12.4	15.4	14.9	17
47	Mali					21.4	22.5	21.2	25	23.8	22.3	24.3	22.4	24.4	22.6	22.5	23.1	23
48	Mauritius	36.3	32.6	37.9	34.3	33.7	31.6	17	16.2	19.6	15.3	13.8	14.5	12.3	13.3	14.9	15.6	24.3
49	Moldova		70.9	62.5	62.8	46.7	49.5	54.5	58.6	63.5	70.8	80.8	84.9	66.5	64.1	61.1	69	64.4
50	Morocco	17.6	16.1	16.2	16.9	20.7	19.2	18.2	18	18.8	18.8	19.2	21.4	19.7	19.4	19	19.2	18.5
51	Netherlands	14.3	13.8	13.5	13.9	12.6	11.9	11.1	11	13	13.1	15.4	16.8	15	9.4	11.5	11	16.4
52	Norway	4.6	3.6	3.6	4.3	3.1	3.7	4.4	5.7	5	4.7							7.5
53	Oman	15.6	13.6	15.3	4.8	4.3	5	5.5	4.9	4.6	4.8	4.3	4.3	4.5	3.7	3.8	4.3	8.2
54	Pakistan	11.9	12.4	12.9	12.3	13	14.4	13.8	14.4	7.9	8.3	7.8	7.5	7.8	7.5	7.8	8.4	11.4
55	Papua New Guinea	34.9	25.8	23.5	27.1	29.3	26.3	22.5	23.4	23.5	28.8	27.9	23.9	22.1	21.3	20	18.4	28
56	Paraguay	30.6	24.9	33.2	26.6	31	26.9	25.5	24.2	20.1	18.5	14.7	19.9	21.8	16.4	18.3	19.5	26.4
57	Peru	21.9	20.2	18.8	19.3	19.9	19.4	19.4	17.2	17.8	15.2	13.2	13.3	12.1	11.9	11.1	9.8	21
58	Philippines	34.8	32.2	31.5	28	33.1	31.3	27	24.7	24.2	26.1	24.9	20.9	21	21.9	17.6	19.5	27.7
59	Poland	51.3	53.1	48.5	49.6	46.2	44.8	44.4	27.4	26.2	25.4	23.1	23.2	24.5	21.3	21.5	19.6	37.1
60	Portugal	12.9	13.8	11.7	10.1	10.6	11.4	12	12	11.5	11	12.1	16.3	19.6	21.8	25.7	25.1	15.9
61	Romania	43.3	62	78.8	61	19.5	21.3	22.1	20.8	19.2	14.8	10.7	12.5	15.7	17.4	18.3		28.9
62	Russian Federation	31.5	31	35.5	41.2	47.1	41.2	34.5	33.5	37.7	31.5	27.9	29.8	26.2	24.1	30.3	28.6	33.2
63	Sierra Leone	21.6	18.5	15.5	20.7	23.5	24	15.2	15.7	17.2	19.2	12.9	13.1	13.7	14	16.2	15.6	18.2
64	Singapore	14.1	17.6	18.2	16.9	17	15.8	15.8	13.2	12.6	12.4	11.8	12.2	11.3	8.4	8.2	8.5	14.2
65	Slovak Republic		14.8	14.8	12.6	9.1	10.3	8.7	8.7	7.9	7.7	7.9	11.7	13.7	14.6	16.8	18.9	11.7
66	Slovenia	44.8	48.5	51.9	50.4	59.6	32	36.8	21.5	18.7	18.9	18.7	22	24.9	21.7	27.4	24.7	30.2
67	Solomon Islands	13.7	13.9	12.2	13.7	10.8	12.6	13.3	18.1	18	18	18.8	20.7	20	17.7	17.2	17.5	15.5
68	Spain	10.2	9.4	10.3	9.4	10.3	9.5	10	10.2	6.3	6.5	7.6	8.2	7.6	8.7	7.6	6	10
69	Sri Lanka	26.8	29.9	30.2	24	29.9	38.7	38.6	32.4	34.7	36.4	28.7	30.1	29.7	22.2	26.1	25.8	27.7
70	Switzerland	8.3	9.1	8.8	6.3	6.4	7.4	7.1	6.8	6.8	6	5.7	7.2	6.1	6	5.9		6.7

Appendix C: Shadow economy (% of GDP) estimates by country (con't)

No.	Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
71	Syrian Arab Republic																			
72	Thailand							56	65.4	59.6	52.9	57.7	63.6	71.2	73.2	72.4	68.3	60.9	59.3	62.1
73	Tonga								15	13.2	15.1	13.2	17.5	16.1	15.8	13.3	15.8	14.3	12.9	17.1
74	Tunisia																26.5	25.6	24.4	23.7
75	Uganda																			
76	Ukraine																			
77	United States	12.8	12.1	11.7	10.4	12.5	9.3	10.8	12.9	11.1	11.5	10.9	10.8	10.4	9.7	8.3	9.1	8.4	9.3	10.1
78	Vanuatu							21.9	28.8	34.5	35.6	36.5	63.7	52.6	48.2	53.4	42.7	46.9	67.5	74.3
79	Vietnam																			
80	Zambia															19.5	16.4	19.8	19	17.9
	Time Average	**13.7**	**13.1**	**13.4**	**14.2**	**14.2**	**15.4**	**18.4**	**20.5**	**21.3**	**20.7**	**19.6**	**20.9**	**21.3**	**19.9**	**21.3**	**21.9**	**20.9**	**22.4**	**22.3**

Appendix C: Shadow economy (% of GDP) estimates by country (con't)

No.	Country	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Country Average
71	Syrian Arab Republic	16.6	16.7	18.6	17.4	18.3	17.6	15.6	16.5	13.8	14.6	17.4						**16.6**
72	Thailand	76.2	84.4	61.1	69.7	66	57.5	78	73.8	68.7	65.3	62.3	69	65.9	63.9	70	59.1	**66**
73	Tonga	22.4	21.6	19.1	17.7	19.5	16.7	15.4	14.2	16.2	25.2	24	27.9	21.7	16.6	15.7	12.3	**17.3**
74	Tunisia	23.6	23.1	23.5	24.4	24.4	26.3	25.7	25.4	24.5	23.4	23.4	24.7	23.8	23.7	22	22.3	**24.2**
75	Uganda			24.2	23.6	17.9	19.1	14.4	16.9	14.5	13.8	14.2	13.7	14.6	18.6	17.1	15.8	**17**
76	Ukraine					23.1	27	29.1	28.1	35.5	34.2	32.2	33.1	27.5	21.7	30	27.7	**29.1**
77	United States	11.3	13.1	13	14.8	17.5	15.1	14.5	14.6	15.4	16.7	18	18.2	15.8	14.4	16.6	16.8	**12.8**
78	Vanuatu	79.7	56.1	41	46.4	46.6	19.1	22.8	30.4	30.2	23.3	20.4	24.7	18.5	14.5			**40**
79	Vietnam		13.7	14.6	16.8	16.1	14.5	13.5	13.6	13	12.6	34.5	41.9	41.1	50.4	49	28.1	**24.9**
80	Zambia	19.7	33.1	28.7	36.5	11.6	12.1	12.5	16.4	17.3	16.1	17.2	20.3	18.2	17.6	20.4		**19.5**
	Time Average	**24.3**	**26.1**	**25.5**	**25.8**	**24.4**	**23.2**	**22.7**	**22.5**	**21.7**	**20.8**	**20.3**	**21.6**	**21.3**	**20.8**	**21.1**	**21**	**23.1**

Source: Authors' own calculation.