Against the Shadow: the Role of e-Government

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ABSTRACT
The shadow economy is defined as economic activities which escape from detection in the official estimates of the Gross Domestic Product (GDP). They erode the tax bases and reduce tax revenue, forcing the government to find other sources to finance their spending. The size of shadow economies is associated with a higher inflation rate, public debt, and unemployment, hence becoming a crucial problem to mitigate, especially in the developing countries. This paper aims to see a possible contribution of e-Government (eGov) implementation to reduce the shadow economy. If institutional and regulatory problems are addressed by introducing eGov, we can avoid predatory and obstructive regulations. This will lower compliance costs and the administrative burdens which have been addressed as among major factors affecting the shadow economy. We investigate this phenomenon on a panel of 128 countries during the period 2003-2013, where the data on shadow economy [1] and the eGov index [2] are both available. The analysis shows that the increasing eGov index significantly reduces the size of the shadow economy. We also found that shadow economy is a latent phenomenon and that the impact of eGov will be greatly conditioned by the severity of the historical phenomenon of the shadow economy.

Keywords
e-Government; shadow economy; growth; developing countries; public administration

CCS Concepts
• Applied computing ~E-government

1. INTRODUCTION
The shadow economy (SE) - unrecorded and unreported economic activities - has been part of long term problems hampering several macroeconomic and financial variables. Among the harms: the SE erodes the tax bases and reduces tax revenue, forcing the government to find other sources to finance public expenditures [3]. The SE is associated with the increase of regional public debts [4]. SE activities are also responsible for a greater size of unemployment [5, 6], deterioration of economic activity and for a reduction in countries' competitiveness [7].

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On the financial side, the SE correlates with a higher inflation rate [8] as well as higher: (1) interest rates paid on sovereign debt, (2) levels of financial instability, and (3) probabilities of sovereign default [9]. A study [10] also found an adverse effect of the SE on credit ratings and lending costs. Another problem associated with the SE is its persistency [7], thus once the SE is established, it is hard to remove.

Given its negative effects, the size of the SE is enormous, especially in the developing countries. It is reported that the average size of the SE as a proportion of GDP, in 1993–2013, varies considerably between countries, depending on the stage of development and the region [1]. Table 1 shows that, by region, the proportion of SE on GDP ranges between 42 to 53% in low income countries, and that countries in Latin America and the Caribbean are more prone to these activities than those in South Asia and Sub-Saharan Africa. The range of the SE in lower middle income countries is wider (between 35 to 62%), again showing a higher incidence in Latin America and the Caribbean than in any other regions. The proportion of the SE in the higher middle income countries is somewhat lower (between 23-40%), where countries in (Eastern) Europe and Central Asia have the greatest proportion among this income group of countries. Moving towards the higher income countries, the proportion is much smaller (between 13-34%), but the largest incidence is yet again found in the Latin America and the Caribbean. Two preliminary conclusions can be drawn from this analysis. First, that SE is relatively clustered in a specific region (in this case Latin American and Caribbean countries). And second, that the shadow activities are larger in low income countries.

Table 1. Shadow economy, average 2003-2013 (% of GDP)

Region	The World Bank income classification			
	Low income	Lower Middle income	Higher Middle income	High income
East Asia & Pacific		34.47	34.20	17.97
Europe & Central Asia		48.99	40.31	21.39
Latin America & Caribbean	52.93	61.56	37.87	34.04
Middle East & North Africa		36.01	25.17	18.34
North America				12.67
South Asia	41.62	35.00	23.33	
Sub-Saharan Africa	43.91	39.38	30.01	

Source: [1]

2. SHADOW ECONOMIES

Shadow economies (SE) are defined as all unregistered economic activities that would have contributed to the officially calculated (or observed) Gross National Product (GDP) if observed. These include unreported income from the production of legal goods and services and the illegal activities – both from monetary or barter transactions. The legal activities are all economic activities that would generally be taxable if they were reported to the tax authorities. [11] detailed the taxonomy of the SE as illustrated in Table 2.

Table 2. Taxonomy of shadow economy

Type of activity	Monetary transactions		Non-monetary transactions	
Illegal activities	Trade with stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling; fraud; etc.		Barter of drugs, stolen goods, smuggling etc. Producing or growing drugs for own use. Theft for own use.	
Legal activities	**Tax Evasion**	**Tax Avoidance**	**Tax Evasion**	**Tax Avoidance**
	Unreported income from self-employment ; Wages, salaries and assets from unreported work related to legal services and goods	Employee discounts, fringe benefits	Barter of legal services and goods	All do-it-yourself work and neighbor help

Source: [11]

The data of SE used in this study refers to [11], which covers all market-based legal production of goods and services that are hidden from public authorities for one or combination of the following reasons:

- to avoid payment of taxes, e.g. income taxes or value added taxes,
- to avoid payment of social security contributions,
- to avoid certain legal labor market standards, such as minimum wages, maximum working hours, safety standards, etc., and
- to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms.

There are several determinants affecting the size of the SE. [7] found a negative, but asymmetric association between GDP and the SE. To illustrate, a US$1 decrease of GDP is associated with a 31-cent increase in the size of the SE, whereas a US$1 increase of GDP results in only a 25-cent decrease in shadow activity. The authors characterized this phenomenon as a hysteresis in the creation and destruction of the SE. Moreover, the study also revealed a negative relationship between the size of the SE and labor quality and the openness of the economy, and vice versa. When all variables are held constant, a more specialized economy entails a lower incentive for firms to enter the shadow.

Other main determinants concern the institutional setting, for instance, bureaucratic complexity. This aspect is found to be a stronger cause of shadow economic activities than the monetary severity [12]. An example is the level of corruption by the government institution [4]. By analyzing data from 126 countries between the years 1996–2012, [13] found a complementarity between the corruption level and SE. Consequently, a reduction in corruption would also lead to a fall in the size of the SE and public debt [13]. The SE can also be influenced by key moments in the institutional setting and, thus, be cyclical. According to [14], in India the size of the hidden economy is approximately 4% less in scheduled election years than in all other years.

The purpose of this study is to investigate the role of digital government in mitigating the problem of SE through administrative burden and bureaucratic cost reduction. Firms have to devote a considerable amount of resources to comply with the government's requirements, namely to fill regular tax declarations, manage the social security status of their employees, or apply for permits to carry out their business [15]. If set at an exorbitant level, these regulation and compliance costs might affect companies (specially the small size ones), and hence might hamper economic growth in general [16, 17]. It is estimated that the total administrative burden on businesses within the European Union was around 600 billion euro per year. The proportion is ranging from 1.5% of GDP in the UK and Sweden to 6.8% of GDP in Hungary, Greece, and the Baltic States [18].

The eGov implementation might possibly contribute to reduce the administrative burden cost and, ultimately, the SE. The application of eGov ensures the smart use of information provided to public authorities by citizens and businesses when implementing administrative procedures. By integrating data systems across administration offices, the government reduces the need for citizens to provide the same data multiple times, while improving the accuracy of the data [19].

3. THE ROLE OF EGOV

The role of technology in general and Information and Communication Technologies (ICT) in particular has been long addressed as driving factors affecting economic performances at both firms' and countries' levels [20]. Technological advancement increases productivity following the framework of the general purpose technology (GPT). The concept is characterized by the potential use of technology gadgets in a wide range of sectors, allowing for gains of productivity to be transferred to the rest of the economy. This aspect is also known as "innovational complementarities", where productivity in the downstream sector increases as a result of innovation in the GPT sector. The contribution of ICTs is acknowledged in several previous studies concerning telecommunications, specifically on the mobile telephony, as well as computer, the Internet and broadband. Many studies using econometric estimations, Input-Output analysis and cost-benefit analysis have quantified and measured the impact of technology on economic variables (namely, growth and employment) [20].

With regards to the role of ICT-related eGov policies, [15] extensively summarized the chains of such policies to reduce administrative burden costs. For instance, based on [21], it is found that centralized governmental portals and websites, online forms, on-line databases of laws and administrative regulations, and e-

procurement are all sources of more efficient administrative procedures. ICT based infrastructure also lowers the time needed for businesses to perform certain activities on information searching, communication and transaction times [22, 23]. Likewise, the elimination of paper handling costs and the reduction of waiting and searching times sum up to a substantial saving for the companies and countries alike. [24] discussed another avenue where eGov implementation affects cost reduction in a reciprocal and event-driven data interchange that can be found in value added tax (VAT), customs declarations, and employee salary specifications.

Other identified channels are: reduction of handling costs of electronic data interchanges systems [25], better coordination of inter- and intra-organizational processes [26], and efficiency of database management between the existing and new database [27].

While these narratives have shown possible ways on how eGov reduces the administrative burden cost, this aspect is still halfway through the final aim to reduce the SE. In this regard, [28] stated: *"the tax authorities should not only make the respective e-government solutions simple and easy to use but should also create incentives for businesses to use them"*.

Focusing on the role of eGov, it is asserted that the primary cause of shadow activity is an attempt to avoid predatory and obstructive regulations. Hence, the benefit of lower regulatory compliance costs is seen as an important remedy [7]. The reduction of the administrative burden on businesses has become an important policy theme. In the EU, for instance, within the context of the Lisbon Agenda, the European Commission launched its agenda on Better Regulation. To reinforce this agenda, by early 2007 the Commission adopted the Action Program for Reducing Administrative Burdens in the European Union. The Action Plan was endorsed by the European Council, which underlined the goal of setting a target to reduce administrative burdens stemming from EU law by 25% by 2012. This reduction could lead to an increase of 1.4% of the EU's GDP (European Commission, 2007) [18].

In the US, the adoption of electronic rulemaking by many federal agencies has provided an opportunity for a greatly enhanced public role — both in terms of the numbers of people who might participate and the depth of their possible participation [29]. Thus, transforming Business-to-Government (B2G) information exchange may result in more efficiency, higher information quality, and reduction of redundant controls. These policies require solid governance and solid investment, which makes the progress slightly slower [30, 31].

Studies conducted by [32, 33] showed that significantly higher entry costs (in terms of time and monetary fees) and stricter entry regulation are correlated with the size of the unofficial economy. To further elaborate, [34] found that reforms in business registration increased the number of registered businesses by 5% in Mexico by former wage earners opening businesses, although it did not support formality made by the existing informal firms. Corroborating this finding, by using a field experiment, [35] found that the incentive to register a company in the formal sector is greater provided that the registration fee was set as low as one-half of the monthly profit in the case of the informal economy in Sri Lanka.

4. METHODOLOGY AND DATA

4.1 Methodology

The purpose of this study is to identify the potential contribution of eGov implementation on reducing the SE. To operationalize, we employ an estimation technique similar to previous studies on this issue [36, 37]. [36] was particularly a more relevant one as the author aims at investigating the impact of the internet penetration rate on SE. The equation to be estimated is the following:

$$SE_{i,t} = \beta_0 + \beta_1 eGov_{i,t} + \sum_{k=2}^{n} \beta_k Xk_{i,t} + \theta_i + \varepsilon_{it} \quad (1)$$

The subscripts *i* and *t* indicate that this analysis employs panel data, with *i* denoting the country and *t* the year. $SE_{i,t}$ is the size of the SE relative to GDP in country *i* and year *t*, and $eGov_{i,t}$ is the level of electronic government. $Xk_{i,t}$ is a vector of control variables that may influence the SE. θ_i denotes the fixed effect of country *i* and ε_{it} is the error term.

We extend this study by acknowledging a possible endogeneity problem in eq.(1), which was neglected in [36]. Thus, whenever the endogeneity problem arises, we employ a two-stage analysis where the first stage estimation aims to estimate the determinants of eGov progress (and other endogenous variables). The first stage estimation for the eGov index is expressed as:

$$eGov_{i,t} = \beta_0 + \sum_{k=1}^{n} \beta_k Xk_{i,t} + \theta_i + \varepsilon_{it} \quad (2)$$

$Xk_{i,t}$ in eq.(2) is a vector of control variables. Thus, we assume that the progress of eGov is not a stand-alone outcome but rather a long process in which many aspects are taken into consideration. From an econometric point of view, unless the Durbin-Wu-Haussman (DWH) test suggests otherwise, the choice of instrument variables is based on two assumptions. First, that the instruments should be relevant and, thus, there should be a correlation between eGov and its instruments, and second, that the instruments should also be valid and, thus, uncorrelated with the unobservable determinants of the dependent variable. Moreover, the standard Hausman procedure is implemented to select the option between the fixed and random effects in the panel model.

We further expand the analysis by estimating a dynamic panel data model which takes into consideration that SE is persistent over time. That is, we introduce in eq. (1) the first lag of the dependent variable. In a linear dynamic panel model, when the sample shows a clear dominance of the number of individuals over time periods, this procedure generates inconsistent estimates of the model's parameters, given that the lagged value of the dependent variable is correlated with the error term. This is the case of the panel dataset under analysis, which includes 128 countries and 11 years of observations. [38] have developed a Generalized Method of Moments (GMM) estimator to overcome the problems referred to above. By first-differencing the equation, individual effects are removed and the new equation is estimable by instrumental variables. Since there is persistence in the series, the extended version of the GMM estimator (the system-GMM estimator) for dynamic panel datasets, proposed by [39] is used in the empirical work.

With regards to the system-GMM method, in addition to the eGov index which is assumed to be endogenous (the size of the SE may influence governments' investments on eGov developments), we also assume that GDP per capita, tax revenue and GDP growth are all endogenous variables. GDP per capita is endogenous as its value is influenced by the size of the SE. If the SE activities were incorporated in the GDP calculation, the value of GDP would also be different (generally larger). A similar reasoning can be applied to the tax ratio which is defined as tax revenue over GDP. In the specification we used the two periods lagged levels of the SE and the other endogenous variables as instruments in the first-differenced equations and their once-lagged first-differences are used in the levels equation. The exogenous variables were used as their own instruments. To support these assumptions, we present

the robustness tests on endogeneity and exogeneity of all independent variables.

4.2 Data

An extensive summary on previous SE studies can be found in [11, 40]. The study [11] detailed problems faced by researchers in this matter, possible methodologies and pros and cons for each method. The SE is defined as all unregistered economic activities that would contribute to the officially calculated (or observed) Gross National Product (GDP). This definition is translated as: "market-based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP". The author estimated the SE using the Multiple Indicators Multiple Causes (MIMIC) model. The concept of the MIMIC model is to examine the relationships between a latent variable "sizes of shadow economy" with a number of observable variables by using their information of covariance. The observable variables are grouped into causes and indicators of the latent variable. The key advantages of the MIMIC approach are that it allows modeling of shadow economy activities as an unobservable (latent) variable and that it considers its multiple determinants (causes) and multiple effects (indicators). The detail of MIMIC model is thoroughly explained in [11].

With regards to eGov variable, there are several alternatives of eGov indices that can be used in this study. Comparing three possible eGov indicators (Accenture, Brown University and UNDESA) commonly used in the eGov studies, the one release by UNDESA is considered to be the most robust one. The assessment is made based on four indicators (i) reproducibility, (ii) coverage of observation, (iii) qualitative assessments (iv) and national scope [41].

The UNDESA E–Government Development Index (EGDI) [2] is based on a comprehensive survey of the online presence of all 193 United Nations Member States, which assesses national websites and how e-government policies and strategies are applied in general and in specific sectors for delivery of essential services. The assessment rates the eGov performance of countries relative to one another as opposed to being an absolute measurement. The results are tabulated and combined with a set of indicators embodying a country's capacity to participate in the information society, without which e-government development efforts are of limited immediate use [2].

The index is a composite measure of three important dimensions of eGov, namely: provision of online services, telecommunication connectivity and human capacity. Additionally, one should also understand that the EGDI is not designed to capture e-government development in an absolute sense; but to give a performance rating of national governments relative to one another. Although the basic model has remained consistent, the precise meaning of these values varies from time to time. This is an important distinction because it also implies that it is a comparative framework that seeks to encompass various approaches which may evolve over time instead of advocating a linear path with an absolute goal [2].

The index is a weighted average of three normalized scores on three most important dimensions of e-government, namely: (1) scope and quality of online services (Online Service Index, OSI), (2) development status of telecommunication infrastructure (Telecommunication Infrastructure Index, TII), and (3) inherent human capital (Human Capital Index, HCI). Therefore the weighted index is formulated as:

EGDI = 1/3 (OSI normalized + TII normalized + HCI normalized)

Other control variables include economic factors, namely the GDP per capita, the GDP growth, the degree of openness of the economy (measured by the weight of imports and exports on GDP), the inflation rate and the tax burden. These variables were collected from the World Bank's database.

5. RESULTS

5.1 Descriptive statistics

We build the scatter plots and bar charts relating the eGov index as the variable of interest in this study and the percentage of SE.

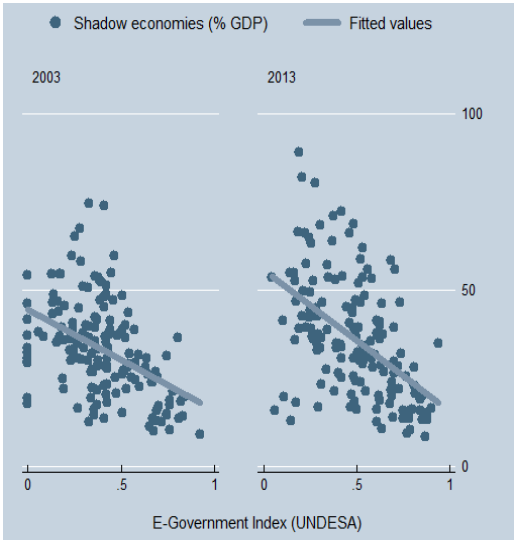

Figure 1. eGov index and the shadow economy (2003 and 2013)

We compared the scatter plots of eGov index and SE in 2003 and 2013 to get the intuition of time dimension of the database. We can infer that in both cases eGov index and SE are negatively correlated. The correlation increases from 47% in 2003 to 53% in 2013. As correlation is not causation this result only signals the close relationship between the two variables. The relationship between eGov and the size of SE and groups of countries according to the World Bank's income classification is shown in Figure 2.

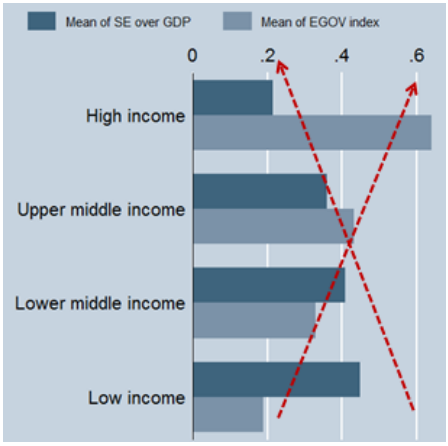

Figure 2. eGov index and SE across income groups

The size of SE activities is larger in low income countries, and decreases slightly as we move up towards the higher income group as shown in Figure 2. We also notice that the gap of eGov index between groups is wider than the gap in SE. This gap is mostly

attributable to the telecommunication infrastructure and online sub indices as presented in the Appendix 1.

5.2 Econometrics results

We present the econometric results in Table 3. We modeled our analysis in five specifications following two main scenarios: SE is not a persistent variable (model 1) and SE is a persistent variable (thus we put the first lag of the SE in the estimation, models 2 to 5). In this study, we strongly put into consideration [5], who found that once the SE is established it is hard to remove it (persistency). This basically means that the current level of the SE is strongly affected by the historical figures of its own data. Whenever the lag of the SE is included in the set of independent variables, we estimate the equation by employing the system-GMM [39]. Moreover, in all estimations we considered the eGov index (g_i100), the GDP per capita and the tax revenue over GDP as endogenous variables.

There are four groups of explanatory variables: 1) the main variable of interest (eGov index) measured in terms of the global index and its three sub-indices (human development index, telecommunications infrastructure index and online index); 2) variables that capture the business cycle (i.e. inflation, and real GDP growth); 3) a fiscal policy variable (i.e. the tax burden); and, 4) other macroeconomic variables (GDP per capita and the degree of openness of the economy). We are also interested in testing the degree of persistency in shadow economy activities, and thus we include the lag of the SE in the estimation. These explanatory variables are selected based on previous studies, mainly [5] but also [36] and [37].

The results suggest that:

- The variable eGov is negatively signed and statistically significant in all estimations. Moreover, the estimated coefficient for the eGov index is ranging between -0.12 in the model that does not include the lag of the dependent variable (Model 1), and -0.05 when the lag is included (Model 2). It can be interpreted that the role of eGov is more important when all countries are at the same initial condition levels. However, when countries differ quite substantially in their SE activities — as in this empirical analysis, the contribution of eGov decreases (the impact is absorbed by the severity of the SE in each country).
- The results suggest that a one percentage point increase in the eGov index leads to a reduction in the size of the SE of 0.05 to 0.12 percentage points of GDP. Therefore, suppose a country can raise its eGov index from 0.51 to 0.52, we might expect a reduction of the SE by as much as 0.05 to 0.12 percentage points. Bearing in mind that this impact is conditional on whether we assume the persistency in the SE phenomenon.
- GDP per capita is statistically significant and negatively signed (in Models 1, 3 and 4). This result is consistent with [7] who found a negative association between GDP and the SE. The authors labeled this phenomenon as a hysteresis in the creation and destruction of the SE. A wealthier society (as indicated by the higher GDP per capita) tends to avoid informality in their economic activities [7].
- Among the variables associated with the business cycle (notably the growth of GDP and inflation), GDP growth is statistically significant and negatively signed in models 1 and 2. However, we do not find a robust relationship between inflation and the SE. GDP growth shows the overall performance of economy and reflects the cyclical aspect of the economic progress. The higher the GDP growth is, the smaller the incentive to hide economic activities from the government.
- The estimated coefficient for the fiscal variable (tax revenue over GDP) is positive, and strongly statistically significant in model 1. This is a rather straightforward result since the tax burden serves as a barrier to formal activities, especially for newly established firm. The same results can also be found in [42], stating that the burden of taxation is among the main determinants of the shadow economy in the EU countries, and particularly in Spain [43].
- Finally, openness is statistically insignificant. We hypothesized that openness deters the SE with regards to specialization [7] the more open the country, the more specialization is needed and thus reduces the level of informality.
- We also disentangle the eGov index into three sub components and found that telecommunications infrastructure and human capital sub indices are both statistically significant with consistent signs (Model 4 and Model 5). However, there is neither conformity when all three sub-indices are put simultaneously nor the significant result of the online sub index individually.

Table 3. Econometric results

	Model 1[1]	Model 2	Model 3	Model 4	Model 5
L.se		0.936***	0.935***	0.951***	0.946***
gdpcap	-0.575**	-0.014	-0.027*	-0.0284**	-0.0002
tax	0.490***	0.015	0.009	0.042	0.040
open	-0.034	0.002	0.0008	0.002	0.002
infla_cpi	-0.060	-0.027*	-0.023	-0.004	-0.008
gdp_g	-0.502*	-0.145**	-0.099	-0.108	-0.125
egov	-0.121**	-0.052**			
Telecom					-0.047***
Human				-0.038**	
Online			-0.028		
m1		-4,91***	-4.86***	-4.94***	-4.97***
m2		-1,48	-1,46	-1,53	-1.46
Hansen		0.262	0.194	0.292	0.414
Observations	941	1,212	1,212	1,212	1,212
Countries	122	128	128	128	128

[1] The robustness tests show that the model has been well specified. Kleibergen-Paap rk LM statistic = 9.854 (The null hypothesis is a full column rank matrix. We reject Ho thus the model is identified), Hansen J-statistic = 4.573 (The null hypothesis is the instruments are valid. We accept Ho), χ^2 of endogeneity test = 9.84 (The null hypothesis states that some of endogenous regressors can actually be treated as exogenous. We reject Ho which means that all assumptions of endogeneity in this model hold.)

Notes:

- The statistical significances for which the null hypothesis is rejected: *, **, *** are set at 1%, ** 5%, and *** 10% significance levels, respectively.
- m1 and m2 are tests for first order and second order serial correlation in the first differenced residual, asymptotically distributed as N (0, 1) under the null of no serial correlation.
- Hansen is a test for the validity of over-identifying restrictions for the GMM estimators, asymptotically χ^2 under the null of joint validity. The figures reported are the p-values.

6. DISCUSSION

As stated in [44], the Digital Government landscape is continuously changing given the need of the governments to offer digital solutions to the social, economic, and political needs of the citizens. Therefore, it is important that policymakers, government executives, researchers and all those who prepare, make, implement or evaluate Digital Government decisions are able to foresee this dynamic and to anticipate its impact. Taking this into account, this paper presents two main contributions: (1) we found that e-Gov improvements may indeed play an important role in mitigating the shadow economy, which hampers many countries, especially the least developed ones; (2) fighting the shadow economy may generate several positive byproduct effects, which range from monetary aspects [3, 4, 5] to non-monetary aspects [45].

The paper stresses the need to implement a more concrete eGovernment road map, especially in developing countries, to reduce the administrative burden cost as the main problem of informality [7, 32, 33, 34, and 35]. We are aware that, given the complexity of the problems associated with these phenomena, our recommendation should not be seen as a sole panacea. However, we expect it to help governmental authorities to reduce the size of the SE by formalizing activities developed underground and turning them into potential revenue bases for government.

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Appendix 1

Descriptive statistic of variables

Variable		*Mean*	*Std. Dev.*	*Min*	*Max*	*Observations*	*Description*
se	overall	33.82479	14.75601	8.29	82.04	N = 2295	Shadow economic activities ratio over GDP (%). Source : [1]
	between		13.79782	9.092667	72.30067	n = 153	
	within		5.340595	3.548789	65.71345	T = 15	
L.se	overall	33.72434	14.62336	8.43	81.45	N = 2142	A year lag of SE.
	between		13.70559	9.074286	72.74786	n = 153	
	within		5.209606	3.976484	66.06648	T = 14	
gdpcap~0	overall	13.09443	18.52242	0.205072	110.0011	N = 2290	GDP per capita (constant 2010 US$). Source : The World Bank, World Development Indicator
	between		18.49649	0.2138437	98.93978	n = 153	
	within		1.941067	-2.47714	27.3141	T-bar = 14.9673	
tax	overall	16.98486	8.429421	0.2309666	95.16069	N = 1635	Tax revenue/GDP (%) Source : The World Bank, World Development Indicator
	between		7.498998	0.2644717	44.06644	n = 136	
	within		3.842493	-0.3722765	88.24302	T-bar = 12.0221	
open	overall	90.27289	56.05719	18.34896	455.4151	N = 2263	Defined as trade volume /GDP (export + import)/GDP (%). Source : The World Bank, World Development Indicator
	between		52.84324	25.36396	381.7658	n = 152	
	within		18.78289	-32.51301	301.1493	T-bar = 14.8882	
infla_~i	overall	6.761221	14.46091	-35.83668	324.9969	N = 2211	Inflation rate measured based on Consumer Price Index (CPI) (%) Source : The World Bank, World Development Indicator
	between		8.234867	-0.2374667	73.20966	n = 150	
	within		11.87986	-57.67235	258.5484	T-bar = 14.74	
gdp_g	overall	4.13872	4.676438	-36.69995	63.37988	N = 2288	GDP growth (annual %) Source : The World Bank, World Development Indicator
	between		2.337038	-0.1600251	15.95547	n = 153	
	within		4.061865	-32.40121	51.56312	T-bar = 14.9542	
egov_100	overall	45.89924	20.67673	0	93.7275	N = 1669	UNDESA E–Government Development Index (normalized in %). Source : [2]
	between		20.07799	6.324091	88.09632	n = 152	
	within		5.108169	12.8737	65.29438	T-bar = 10.9803	
telc~100	overall	24.64017	23.51107	0.154	88.531	N = 1669	Telecommunication Infrastructure Index (TII) part of UNDESA E–Government Development Index (normalized in %). Source : [2]
	between		22.48616	0.899	81.25232	n = 152	
	within		7.019093	-0.4491685	58.01666	T-bar = 10.9803	
huma~100	overall	75.89678	19.96467	0	100	N = 1669	Human Capital Index (HCI) part of UNDESA E–Government Development Index (normalized in %). Source : [2]
	between		19.35601	20.00864	99.3535	n = 152	
	within		5.050248	7.859285	99.14669	T-bar = 10.9803	
ol_100	overall	38.29213	24.1148	0	100	N = 1669	Online Service Index (OSI) part of UNDESA E–Government Development Index (normalized in %). Source : [2]
	between		22.2537	0.1789545	97.53059	n = 152	
	within		9.401547	-4.570875	73.82986	T-bar = 10.9803	

Correlation matrix

	(1) *se*	*(2)* *L1.se*	*(3)* *gdpcap*	*(4)* *tax*	*(5)* *open*	*(6)* *infla_cpi*	*(7)* *gdp_g*	*(8)* *egov*	*(9)* *telcom*	*(10)* *human*	*(11)* *ol_100*
Se	1										
L1.se	0.9722	1									
Gdpcap	-0.5993	-0.6021	1								
Tax	-0.1586	-0.1694	0.3027	1							
Open	-0.1352	-0.14	0.205	0.1302	1						
infla_cpi	0.1717	0.1729	-0.3075	-0.0874	-0.0265	1					
gdp_g	0.0691	0.0966	-0.2536	-0.1805	0.0433	0.1939	1				
Egov	-0.5583	-0.5545	0.7512	0.3036	0.1603	-0.3129	-0.3399	1			
Telcom	-0.573	-0.5723	0.8378	0.307	0.1987	-0.3384	-0.3875	0.9257	1		
Human	-0.4256	-0.4205	0.5361	0.315	0.1602	-0.1797	-0.2442	0.8094	0.6644	1	
Ol	-0.4934	-0.4898	0.6171	0.2004	0.0745	-0.2835	-0.2596	0.9089	0.7867	0.5936	1

Based on [46], two highly correlated variables (with more than 80% correlation coefficient) should not be put in the same equation to avoid a problem of multicollinearity. High correlation coefficients are found between eGov index (8) and its sub components (9), (10) and (11) as eGov index is the summation of these three sub indices. In this study, these sub indices are never put in the same equation as eGov.