Does Shadow Economy matter for Technical Efficiency? A Cross Country Analysis

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Abstract

This article examines the link between technical efficiency and the level of the shadow economy in a sample of 119 countries during the period 1991-2015. The results reveal that shadow economy is associated with significantly lower levels of technical efficiency. This finding is not affected by the inclusion of various covariates that may influence both the shadow economy and the efficiency. This result is robust to a number of robustness tests.

Keywords: Shadow Economy, Technical Efficiency

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1 Introduction

Technical efficiency is essential for countries that aim to make the most of its available resources. On the other hand, the shadow economy, which comprises all currently unregistered economic activities that would contribute to the officially calculated gross national product if they were recorded, is a pervasive feature of countries throughout the world. In fact, high levels of shadow economy implied by tax evasion and tax avoidance can pose serious problems for the public sector because (i) they lead to a loss of revenue in terms of unpaid income tax, public social security contributions and VAT and (ii) because of they reduce government's available resources for investing in economic development thereby decreasing the quality and scope of public policies implemented (Schneider, 2000).

However, the most pervasive effect of the shadow economy is not the revenue lost by government but the inefficiency it conveys and spreads to the functioning of the economic system. This unregulated economic activity is likely to generate a waste of resources in control, tax enforcement and punishment activities in the public sector. Considering the government as a provider of public goods and services financed by tax revenues, tax evasion is detrimental to welfare given that it adds to the excess burden of taxation because some of the costs of evasion are real resource costs and not just transfers (Feldstein, 1999; Chetty, 2009). As explained by Balafoutas *et al.* (2015) such real costs and efficiency losses may emerge when taxpayers try to conceal and tax authorities try to detect tax evasion (Bayer, 2006), when tax evasion imposes uncertainty on risk-averse evaders (Yitzhaki, 1987) and when tax-evading firms (with higher production cost than average) drive tax-honest ones out of the market because they conceal real revenues (Strand, 2005).

Nevertheless, to date, there are no studies analyzing the relationship between the shadow economy and the level of technical efficiency. Hence, this article fills this gap in the literature by analyzing the link between technical efficiency and the shadow economy in a sample of 119 countries during the period 1991-2015 by means of panel data econometric models.

2 Data and Preliminary Evidence

In this section, we describe the measurement of our key variables through the paper: (i) the level of technical efficiency and (ii) the level of shadow economy.

Technical Efficiency

Technical efficiency occurs when maximum output is obtained from a given input level, or minimum input is used to obtain a given output level. Technical efficiency analysis can therefore have an output-maximization orientation or an input-minimization orientation. Farrel (1957) defines technical efficiency as: "one minus the equi-proportional reduction in all inputs that still allows the production of given outputs". Hence, a country is said to be technically efficient when it is impossible for it to achieve an equi-proportional reduction in input while obtaining a given level of output. Based on this definition, a score of less than one reflects some degree of technical inefficiency. In this study, we use the DEA methodology developed by Charnes *et al.* (1978) which generalizes Farrell's definition for multi-output contexts to calculate efficiency scores.

The performance of each country is measured relative to an envelopment surface composed of other countries from the sample representing current technology. Those countries that are enveloped by the surface are classed as efficient; while those outside it are classed as inefficient. The closer the country is to the border or frontier, the greater its efficiency. As our base-line metric, we employ the assumption of variable returns to scale and a maximum-output-oriented measurement given that a country will aim to produce the maximum quantity of goods and services from its available resources.

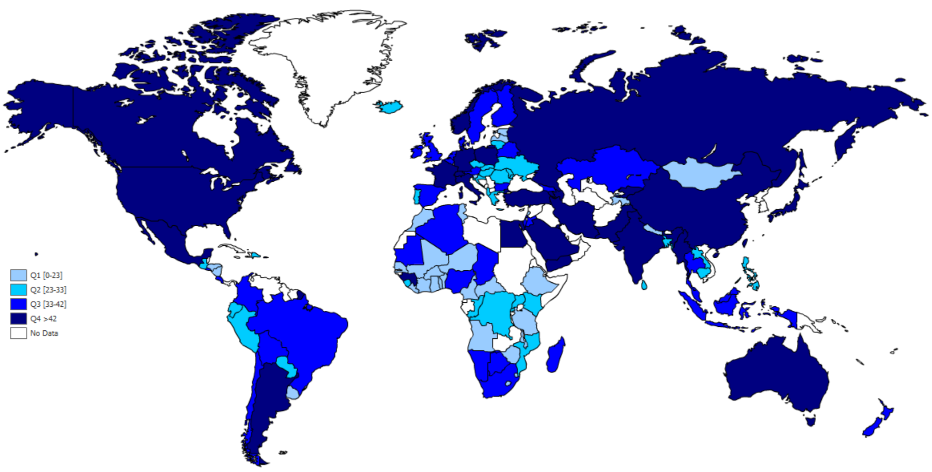
Formally, efficiency can be calculated as the solution to the following maximization problem:

$$
\begin{aligned}
Max \oslash_0 \\
st: \\
x_{ji0} - \sum_{i=1}^{n} x_{ji}\lambda_i \geq 0, j = 1, \ldots, m \\
-\oslash_0 y_{ri0} + \sum_{i=1}^{n} y_{ri}\lambda_i \geq 0, r = 1, \ldots, k \\
\sum_{i=1}^{n} \lambda_i = 1, i = 1, \ldots, n \\
\lambda_i \geq 0, \forall i
\end{aligned}
\tag{1}
$$

where y denote the outputs, x the inputs and λ_i are the weights on the n countries, which allow the construction of the composite efficiency index $1/\oslash_0$ where $\oslash_0 = y\lambda$. In particular, the inputs employed are the stock of capital and the level of employment (measured in millions of people) whereas the output is the real GDP per capita of the country. The data used to calculate the efficiency index is taken from the Penn World Tables.

Figure (1) below, plots the spatial distribution of average efficiency scores during 1991-2015 in our sample of countries. As observed, top countries in efficiency scores are observed in large countries such as United States (100), China (98), Russia (96.7), but also in oil-producers such as Saudi Arabia (100), Kuwait (98.8) or Norway (95.6). The lower scores are observed in African economies such as Zimbawe (18.99), Central African Republic (16.9), Liberia (19.1) or Niger (15.4) but also in some Asian countries such as Mongolia (25.8) and Tajikistan (11.28).

Figure 1: The Geographical Distribution of Efficiency

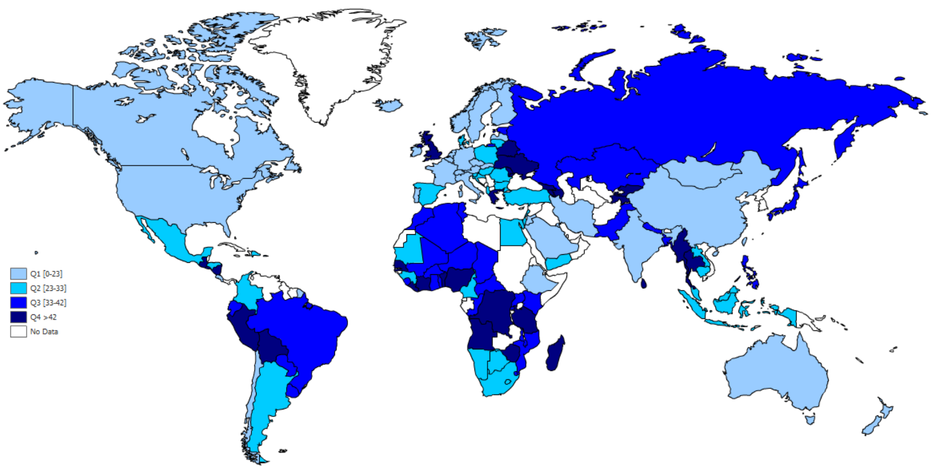


Shadow Economy

The shadow economy, on the other hand, refers to all economic activities that contribute to the gross national product but are currently unregistered. However, gathering information about underground economic activity is difficult, because no one engaged in such activity wants to be identified. To redress the lack of data, different methods are employed in the literature to measure the shadow economy. The methods to measure the size and evolution of the underground economy are classified as direct and indirect. Direct approaches are based on micro-data and micro-models, which use data based on surveys or fiscal audits. Direct approaches have as a main problem the data collection (which is very expensive in time and money) and its inaccuracy (the members of the sample do not want to report submerged activities even when the consultations are anonymous). Thus, we rely on indirect metrics of the shadow economy provided by:

Figure (2) plots the spatial distribution of the shadow economy during 1991-2015 in our sample of countries. As observed, the pattern is a considerable degree of heterogeneity across-countries. We find that countries with lower levels of shadow economy such as Switzerland (7.2%), United States (8.3%), Austria 8.9%, Netherlands (10.7%), France (11.1%), Australia (12.1%) or Sweden (13.2%) whereas countries with highest levels of shadow economy are Greece (54%), Nigeria (56%), Zimbawe (60%) and Bolivia (62%).

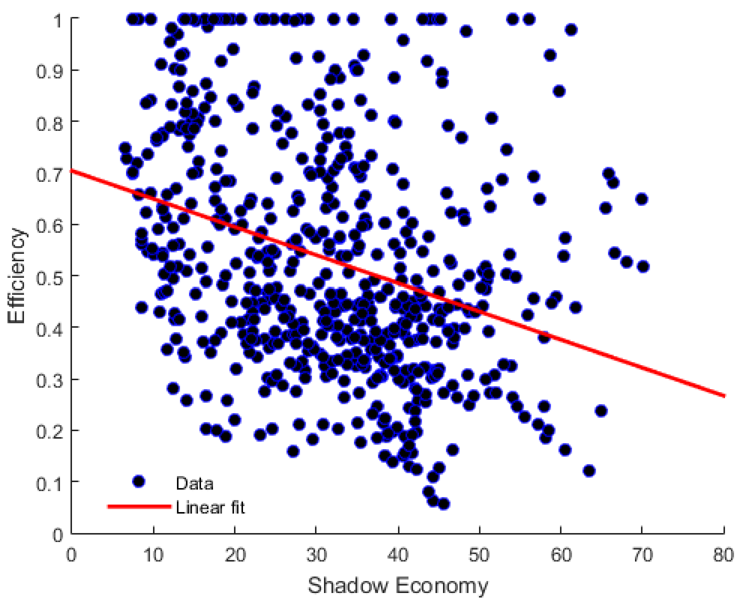
Figure 2: The Geographical Distribution of the Shadow Economy



The Link Between Shadow Economy and Efficiency

Figure (3) provides a graphical illustration on the association between average levels of shadow economy and efficiency at the global scale during the period 1991-2015. The scatter plot suggests the existence of a negative relationship between shadow economy and efficiency. This means that countries with lower levels of shadow economy tend to have a higher level of efficiency while those countries with higher levels of shadow economy are characterized on average by a lower efficiency. The link is statistically significant (t-value is -8.21), and the measure of shadow economy alone explains around 10.2% of variation in cross-country efficiency. Nevertheless, when interpreting the information provided by Figure (3), it should be noted that it is very likely that technical efficiency does not depend exclusively on the level of shadow economy. This implies that the empirical evidence displayed in Figure (3) should be considered with some caution, as omitted variables could ultimately affect the perception of the connection between shadow economy and efficiency. In view of this problem, in the next section we develop a more appropriate statistical analysis on the link between efficiency and the shadow economy.

Figure 3: The Link Between Shadow Economy and Efficiency



3 Empirical Model

To investigate the link between efficiency and the shadow economy we begin our empirical analysis with a panel data model including country fixed effects. The model reads as:

$$\mathbf{EF}_t = \mu + \lambda \mathbf{SE}_t + \mathbf{X}_t \beta + \epsilon_t \tag{2}$$

where **EF** and **SE** are, respectively $N \times 1$ vector consisting of observations for each country in the sample ($i = 1, \ldots, n$) at a particular point in time $t = 1, \ldots, T$ on the measures of efficiency and the shadow economy.[1] $\mathbf{X}$ is a $n \times k$ matrix of a set of variables that control for different factors that are assumed to have an influence on

[1] Our panel data set consists of $N = 119$ countries and $T = 5$ periods. Time periods correspond to five-year averages such that t1=1991-95, t2=1996-2000, t3= 2001-2005, t4=2006-2010 and t5=2011-2015.

efficiency. In turn,$\boldsymbol{\epsilon}$ is the corresponding $n \times 1$ innovation vector. Our main interest throughout the paper is in coefficient λ, which captures the effect of the quality of government on regional resilience.

The set of controls included in X consists on economic variables, socio-demographic factors and political factors. Table (1) presents the detailed definition and sources of all the control variables used in the paper. Several descriptive statistics are included in Table 1.. Economic controls consist on (i) the share of natural resource rents in the GDP, (ii) the degree of trade openness and (iii) the share of military spending on GDP. As regards the set of socio-demographic controls we include (iv) an index of social group discrimination, (v) a composite index of education and (vi) the share of urban population. To control for disparities in the political system and the institutional design we account for (vii) the level of democracy and (viii) an index measuring the respect of property rights.

Table 1: Descriptive Statistics

Variable	Mean	Std	Definition	Source
Efficiency	0.530	0.230	Technical Efficiency (DEA VRS)	PWT
Efficiency	0.426	0.177	Technical Efficiency (DEA CRS)	PWT
Shadow Economy	31.835	13.488	Shadow economy (% of GDP)	
Natural resources	8.114	11.910	Natural resource rents (% of GDP)	QOGI
Trade Openness	75.143	34.716	Trade Openness (% of GDP)	WDI
Military spending	2.246	2.260	Militar Spending (% of GDP)	WDI
Discrimination	2.697	0.846	Social group discrimination index [0.4]	VDEM
Education	45.480	16.937	Composite index of education including:	
			(i) average years of education	Barro and Lee (2013)
			(ii) per capita university students	CNTS
			(iii) literacy rates	CNTS
Urbanization	102.541	134.561	Percentage of population living in cities	WDI
Democracy	4.060	6.105	Polity IV index [-10, 10]	SPP
Property rights	0.711	0.202	Property rights index [0.1]	VDEM

Notes: SPP stands for Systemic Peace Project, VDEM Varities of Democracies, WDI world development indicators, CNTS cross national time-series and PWT Penn World Tables.

4 Results

Table (2) below presents the results of our econometric analysis. Column (1) presents Pooled OLS estimates, whereas in column (2) fixed-effect estimates allowing us to control for unobserved spatial heterogeneity are reported. Column (1) shows there is a negative and significant relationship between the shadow economy and the level of efficiency. It should be noticed that the fixed effects model results reported in Column (2) just exploit time-variation which changes the signs in the observed relationship between efficiency natural resources, military spending, education and democracy. However, the effect of the shadow economy holds negative and significant at the 1% level.

Focusing on the significance of the estimated parameter of the shadow economy, an important issue is to check whether or not it remains significant when controlling for heteroscedasticity and temporal correlation in the error term of the model. To address these potential problems in the quality of the estimates, in Column (3) we report the results obtained when employing the robust covariance-matrix estimator (HAC) proposed by Arellano (2003) in the context of a fixed-effects panel data model.[2]

As observed, the negative impact of the shadow economy on the level efficiency remains significant at the 1% level. Finally, in Columns (4) and (5) we provide the results obtained when including time-period dummies to make sure our results are not driven by common shocks affecting technical efficiency in all the countries in our sample. Controlling for unobserved time heterogeneity has non-negligible effects on the sign and significance of the remaining control variables included in X. Nevertheless, in this context, the observed link between shadow economy and the level of technical efficiency remains negative and significant at the 5% level.

Finally, in Table (3) we present the outputs of the econometric analysis when employing a different efficiency variable, based on the assumption of constant returns to scale. The observed link between the shadow economy and the technical efficiency is found to be significant at the 5% level in all the models but in the fixed and time-period dummies with a HAC estimator where it is only weakly significant. Taken together, these findings suggest there is a robust and negative link between shadow economy and efficiency, that is independent of the way of processing the data.

[2] The robust estimator of Arellano (2003) is HAC provided the panel is of the large N small T variety and it is given by:

$$\Sigma_A = \left(X'X\right)^{-1} \Sigma_{i=1}^{n} X_i' \hat{\epsilon}_i \hat{\epsilon}_i' X_i' \left(X'X\right)^{-1} \quad (3)$$

Table 2: Main Results

	Pooled OLS (1)	Fixed Effects Model (2)	Fixed Effects Model (HAC) (3)	Fixed Effects Model (4)	Fixed Effects Model (HAC) (5)
Constant	0.5032***	0.8625***	0.8625***	0.9013***	0.9013***
	(7.51)	(9.78)	(6.50)	(10.19)	(6.25)
Shadow economy	-0.0033***	-0.0055***	-0.0055***	-0.0038***	-0.0038**
	(-4.39)	(-5.17)	(-3.23)	(-3.08)	(-2.30)
Natural resources	0.0026***	-0.0017***	-0.0017	-0.0017***	-0.0017
	(3.32)	(-2.91)	(-1.20)	(-2.91)	(-1.19)
Trade Openness	-0.0015***	-0.0004**	-0.0004	-0.0006**	-0.0006
	(-6.23)	(-2.04)	(-1.48)	(-2.53)	(-1.63)
Military spending	0.0076**	-0.0044**	-0.0044*	-0.0047**	-0.0047*
	(2.00)	(-2.21)	(-1.81)	(-2.37)	(-1.84)
Discrimination	-0.0646***	-0.0058	-0.0058	-0.0031	-0.0031
	(-5.47)	(-0.50)	(-0.42)	(-0.27)	(-0.24)
Education	0.0055***	-0.0026***	-0.0026	-0.0046***	-0.0046**
	(8.61)	(-2.66)	(-1.36)	(-4.07)	(-2.01)
Urbanization	-0.0001**	0.0002	0.0002	0.0001	0.0001
	(-2.00)	(1.18)	(1.03)	(0.45)	(0.42)
Democracy	-0.0043**	0.0025**	0.0025	0.0021*	0.0021
	(-2.24)	(2.08)	(1.43)	(1.74)	(1.23)
Property rights	0.2281***	0.0107	0.0107	-0.0030	-0.0030
	(3.79)	(0.19)	(0.14)	(-0.05)	(-0.04)
Period Dummies	No	No	No	Yes	Yes
R2	0.304	0.934	0.934	0.936	0.936
Log Like	137.93	839.60	839.60	852.51	852.51

Notes: The dependent variable is in all cases the technical efficiency metric calculated under the assumption of variable returns to scale. * significant at 10% level, ** significant at 5% level, *** significant at 1% level. (t-stats provided within parenthesis).

Table 3: Robustness: Definition of Efficiency

	Pooled OLS (1)	Fixed Effects Model (2)	Fixed Effects Model (HAC) (3)	Fixed Effects Model (4)	Fixed Effects Model (HAC) (5)
Constant	0.3190***	0.6889***	0.6889***	0.6891***	0.6891***
	(5.93)	(8.53)	(6.61)	(8.82)	(6.17)
Shadow economy	-0.0013**	-0.0034***	-0.0034**	-0.0027**	-0.0027*
	(-2.16)	(-3.51)	(-2.59)	(-2.47)	(-1.89)
Natural resources	0.0032***	-0.0010*	-0.0010	-0.0007	-0.0007
	(5.02)	(-1.86)	(-1.26)	(-1.40)	(-0.90)
Trade openness	-0.0010***	-0.0005**	-0.0005**	-0.0005**	-0.0005*
	(-5.34)	(-2.53)	(-2.17)	(-2.31)	(-1.72)
Military spending	0.0118***	-0.0044**	-0.0044**	-0.0050***	-0.0050**
	(3.86)	(-2.44)	(-1.99)	(-2.88)	(-2.11)
Discrimination	-0.0240**	-0.0059	-0.0059	-0.0055	-0.0055
	(-2.53)	(-0.55)	(-0.51)	(-0.55)	(-0.51)
Education	0.0040***	-0.0014	-0.0014	-0.0023**	-0.0023
	(7.81)	(-1.49)	(-0.84)	(-2.30)	(-1.24)
Urbanization	0.0000	-0.0001	-0.0001	-0.0001	-0.0001
	(-0.77)	(-0.52)	(-0.40)	(-0.83)	(-0.65)
Democracy	-0.0029*	0.0014	0.0014	0.0015	0.0015
	(-1.89)	(1.30)	(0.99)	(1.46)	(1.05)
Property rights	0.1034**	-0.0240	-0.0240	0.0049	0.0049
	(2.14)	(-0.47)	(-0.40)	(0.10)	(0.07)
Period Dummies	No	No	No	Yes	Yes
R2	0.238	0.906	0.906	0.916	0.916
LogLike	268.19	892.06	892.06	926.31	926.31

Notes: The dependent variable is in all cases the technical efficiency metric calculated under the assumption of constant returns to scale. * significant at 10% level, ** significant at 5% level, *** significant at 1% level. (t-stats provided within parenthesis).

5 Conclusions

This article examines the link between technical efficiency and the level of the shadow economy in a sample of 119 countries during the period 1991-2015. The results reveal that shadow economy is associated with significantly lower levels of technical efficiency. This finding can be explained by the waste of public capital and public sector resources in control, tax enforcement and punishment activities.

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