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Does Corruption Affect Total Factor Productivity?
An empirical analysis

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Abstract

The negative role of corruption in the economies is strongly claimed in economic research. The fact that it undermines economic growth is beyond doubt. Still mixed evidences persist about how corruption reaches growth. This paper examines the effect of corruption on total factor productivity (TFP), also referred to as Solow residual, and assesses the impact related to the increase in tax rates on this effect. The motivation of this study is that volumes of research show that growth of output in a large extent results from growth in TFP. The results of the estimations unambiguously suggest that corruption, well as tax burden, has a negative effect on TFP. When both variables alongside with the lagged dependent variable are used for controlling TFP, the finding suggests that one-unit increase in corruption standard deviation is associated with a decrease of 0.01% in TFP, and the increase in tax burden in the same proportion leads to a decline in TFP of 0.13%. Furthermore, our findings highlight that, a tax rate increase would result an aggravation of the negative impact of corruption on TFP. These findings remain robust to the introduction of TFP determinant variables over alternative regressions.

Keywords: Total factor productivity, Corruption, Tax evasion

JEL classification: D73, O47, H26

1. Introduction

The issue of how much of growth in output results from growth in physical and human capital is an essential point of Solow growth theory (Solow, 1956; Swan, 1956). Researches show that under the assumptions of constant returns to scale and competitive factor markets such an exercise, also referred to as growth accounting, is well possible.

The empirical investigations by Abramovitz (1956) show that growth of factors of production contributes only of 10% of output growth per capita in the US during 1869–1878 and 1944–1953. Over the time span of 1900–1949, Solow (1957) points out that the output growth per worker explained by capital accumulation is 12%. This is to say that both studies suggest that growth of output per worker is explained more than average by sources other than human/physical capital. This deviation between the observed output and that forecasted through human and physical capital is total factor productivity (TFP), also fairly referred to as "Solow residual". This *a priori* unknown productivity, actually, would come from sources like innovation, or improvement in the institutional context.

Even though the recent work suggest that the level of this residual has significantly declined, it is however very far from zero (Kendrick, 1961; Jorgenson, Frank, & Barbara, 1987; Abramovitz & David, 2000). For example, the empirical work of Baier, Dwyer, & Tamura (2006) on 143 countries with 23 among them with 100 years time span, finds TFP to contribute about 14% of growth of the output per worker in average in those countries, representing strikingly 26% of economic growth for Southern Europe, 26% for Newly Industrialized Countries, and 34% for Western countries. However for Sub-Saharan Africa and Middle East countries, the effect of TFP is found to be negative. Another noteworthy remark is that the variation in output per worked is more sensitive to the variation of TFP than variation in the classical factors, i.e. human and physical capital. Intuitively, one may presume that factors whatsoever might channel TFP to impact economic growth. This becomes even more likely as its correlation with TFP gets stronger.

At the same time, volumes of scientific communications on corruption subject highlight its influence on economic growth. However, in a larger extent there is a consensus that corruption is negatively associated with the growth of the economy and seriously affects volume and especially the quality of the main factors of production.

Mauro (1995)'s estimations give support to the negative effect of corruption on per capita GDP growth; but such an effect is not robust when the ratio of investment to GDP is included among the explanatory variables. A significant negative impact is also reported in the study of Keefer & Knack (1995), Mo (2001). Shleifer & Vishny (1993) also provide a thorough analysis in grasping detrimental implications of corruption in the economy (see also Bardhan, 1997; or Ades & Di Tella, 1999). Tanzi & Davoodi (1997), on the other hand, first making the assumption that the quality of investments may constitute an enhancing factor to productivity of capital, conclude that corruption affects the quality of the infrastructures, in line with Gillanders (2013). Curiously very few studies focus on the impact of corruption on human capital, albeit the mainstream pattern, again, argues for its detrimental aspects (Seka, 2013; Dridi, 2014; Bryant & Javaldi, 2016). The work of Pellegrini & Gerlagh (2004) analyses the direct and indirect effects of corruption on economic growth, and identifies by importance, investment, trade policy, schooling, and political instability relating variables, as corruption transmission channels. All are found to be negatively associated with corruption except political instability, which in contrast stirs it up. Beyond its negative direct impact on growth, corruption may also indirectly impact it through the transmission channels (*ibid.*, 2004).

On the other hand, it should be also mentioned that the literature on corruption also records an alternative view other than that systematically claiming the pernicious effect of corrupt activities for the economy. However, corruption seems to be beneficial only in the presence of deficient governance with ineffective institutions – otherwise it overall reduces economic growth. The following work shed light on this issue: Leff (1964); Leys (1965); Méon & Sekkat (2005); Méndez & Sepúlveda (2006); Aidt, Dutta, & Sena (2008); or Kéïta & Laurila (2016a, b, c).

Starting with Paldam (1999)'s thought that the absence of corruption may constitute a growth factor, also supported in Lambsdorff (1999), the paper estimates the impact of corruption on TFP. Then, due attention is paid to examining the incidence of tax burden on such impact. If the increase of the size of the State through more public expenditure is seen as almost inherent to rent-seeking activities (Dzhumashev, 2014), one may also presume on the other hand that in best-governed countries – namely those subject to less tax evasion – tax rates may increase without necessarily triggering more corruption, and hence impacts further TFP. In such circumstances, one could even expect from fiscal revenues increases to foster TFP growth, as they may finance changes in production technology, allow more support for innovation, and help in strengthening institutional capacity of countries. In any cases, it seems important to shed some light on how TFP responds to tax increases.

The paper is organized as follow: following this section, *Section 2* presents the baseline model and data to be used, and explains the empirical method applied. *Section 3* presents and discusses the empirical findings, while *Section 4* is dedicated to conclusions and policy recommendations.

2. Data and method

2.1 Data

The paper develops an empirical study covering a total of 90 countries worldwide, reported in *Appendix* (*Table 7*), for a time span of 1996–2014. To ensure the reliability of the study, countries to be part of the sample have been selected according to the availability of data.

Following the discussions in the previous section, the paper focuses on *Equation (1)* below as the baseline model for the empirical analyses. The model reads:

$$TFP_{i,t} = \beta Corruption_{i,t} + \gamma TaxBurden_{i,t} + \lambda Z_{i,t} + \varpi_i + \eta_t + \varepsilon_{i,t} \qquad (1),$$

On the left-hand side of *Equation (1)*, $TFP_{i,t}$, symbolizes the levels of total factor productivity at constant purchasing power parity (PPP) rates, relative to the United States in terms of the prices in that period, for country i in period t. It represents the dependent variable of the model. Statistics associated hereby come from *Penn World Table, version 9.0.* (Feenstra, Inklaar, & Timmer, 2015). On the right-hand side, $TFP_{i,t}$ is estimated, among others, against $Corruption_{i,t}$ and $TaxBurden_{i,t}$. The study uses the corruption perception index (*CPI*) from *Transparency International* to capture the prevalence of corruption. However, note that as its name indicates, *CPI* is based on the perception of how widespread corruption is within the country. This is to say that such an assessment is likely to be biased because of its subjectivity. Since corruption is an illegal activity and therefore usually hidden deliberately, the statistics related to proven cases do not suffice to evaluate it. *CPI* ranges from 0 to 10, where 0 stands for the highest-level possible of corruption and 10 indicates full integrity in the country. However, for ease in interpreting estimations we have rescaled the corruption figures so that their increase also indicates further corruption in the country. The rescaling method is as follow: $Corruption_{i,t} = 11 - CPI_{i,t}$. The variable of interest $TaxBurden_{i,t}$, assesses the level of fiscal burden borne by taxpayers. Its measurement includes both marginal tax rates and the overall level of taxation (both direct and indirect taxes) imposed by the government (both central and local levels) as a percentage of gross domestic product (GDP). Here, we use *Fiscal freedom* statistics provided from the Economic freedom index database *(The Heritage Foundation)*.

The paper hypothesizes that both relatively high level of corrupt activities and a-more-than optimal taxation constitute, among others, factors likely to drastically shrink the TFP of a country due to loss of competitiveness. β and γ stand for the respective coefficients of corruption and tax burden; they are expected to be negative ($\beta \prec 0$, $\gamma \prec 0$). *Figures 1–3* plot the nature of the nexus between the variables of interest. *Figure 1* suggests a strong negative correlation between TFP and corruption. The paper also provides for possible comparison regional graphics plotting this relationship (see *Appendix*). *Figure 2* at first glance also indicates a negative relationship between TFP and tax burden. However, the regression line representing fitted values is practically horizontal, which suggests a weak correlation between both variables. *Figure 3* shows a positive linkage of corruption and tax burden. Textbooks also argue that over-taxing may encourage agents to avoid paying taxes by bribing tax officials, or resorting to frauds and black-marketeerings. Those are known to considerably foster shadow economy that leads in turn to a decline in public revenue, and implying *in fine* a less-than-optimal allocation of public resources, all things being equal.

Furthermore, the modelling also includes a set of other explanatory variables. They are accounted by $Z_{i,t}$, which is their vector of variables and λ, their vector of coefficients. ϖ_i and η_t meanwhile capture the respective country specific effect and the relevant time effect. While $\varepsilon_{i,t}$ in the end, represents a random error term that takes into account the influence of all omitted variables in the estimation.

Descriptive statistics relative to variables as well as sources are reported *Table 1*. Since our data have the time dimension we firstly ensure that the time series are stationary, meaning that their distribution neither follows any trend nor changes over time. The Fisher type unit-root test is applied – with the null hypothesis that all panels contain a unit root, i.e. nonstationarity; against the alternative hypothesis that at least one panel is stationary. *Table 6* in *Appendix* reports the *Chi*-squares and *p*-values associated to both Augmented Dickey-Fuller (AD-F) and Phillips-Perron (P-P) methods. In both cases, the non-stationarity hypothesis is systematically rejected.

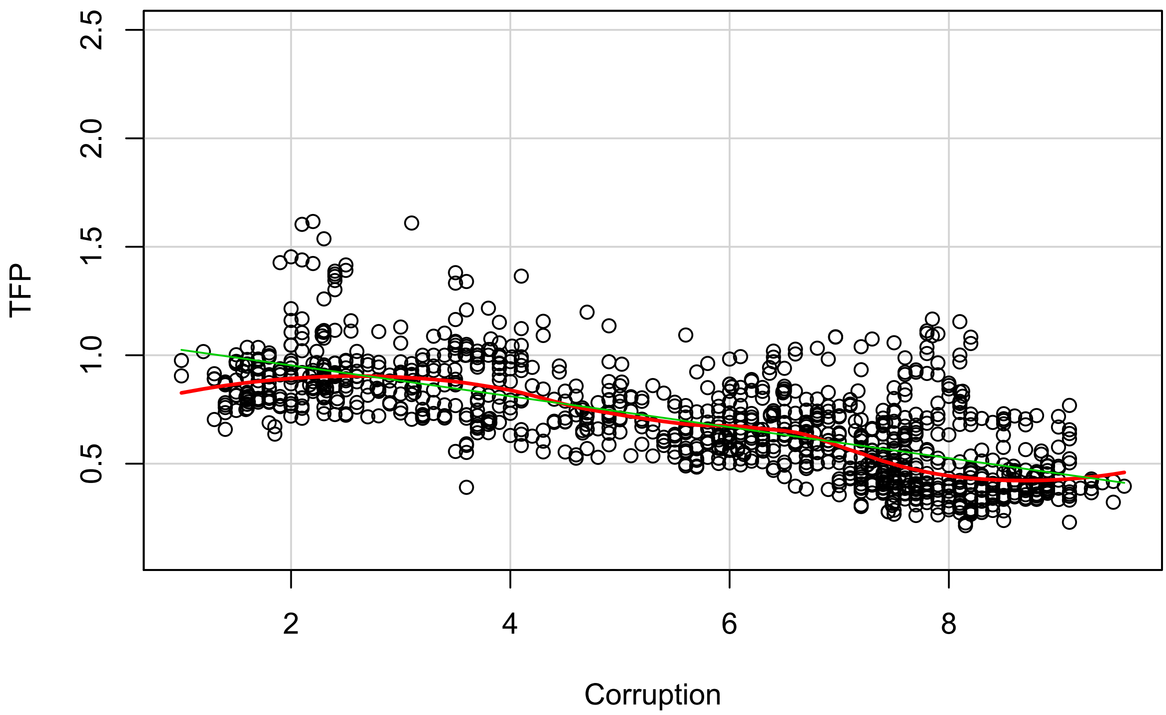

Figure 1. *Total factor productivity (TFP) with respect to Corruption*

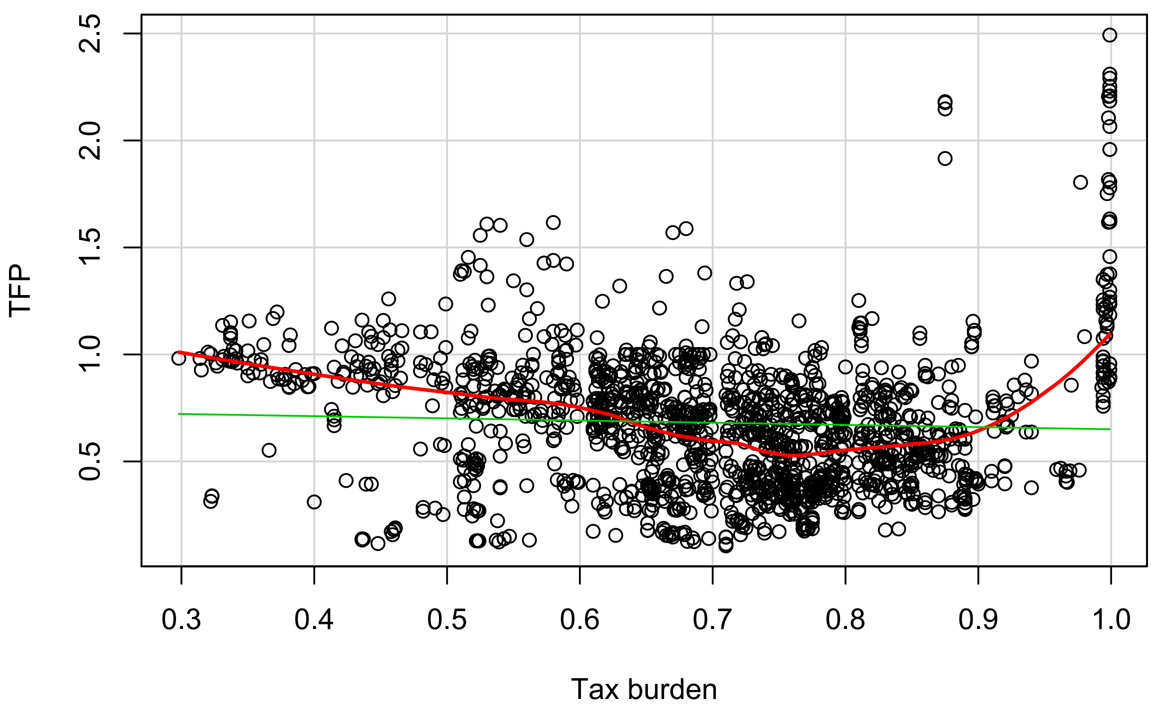

Figure 2. *Total factor productivity (TFP) with respect to Tax burden*

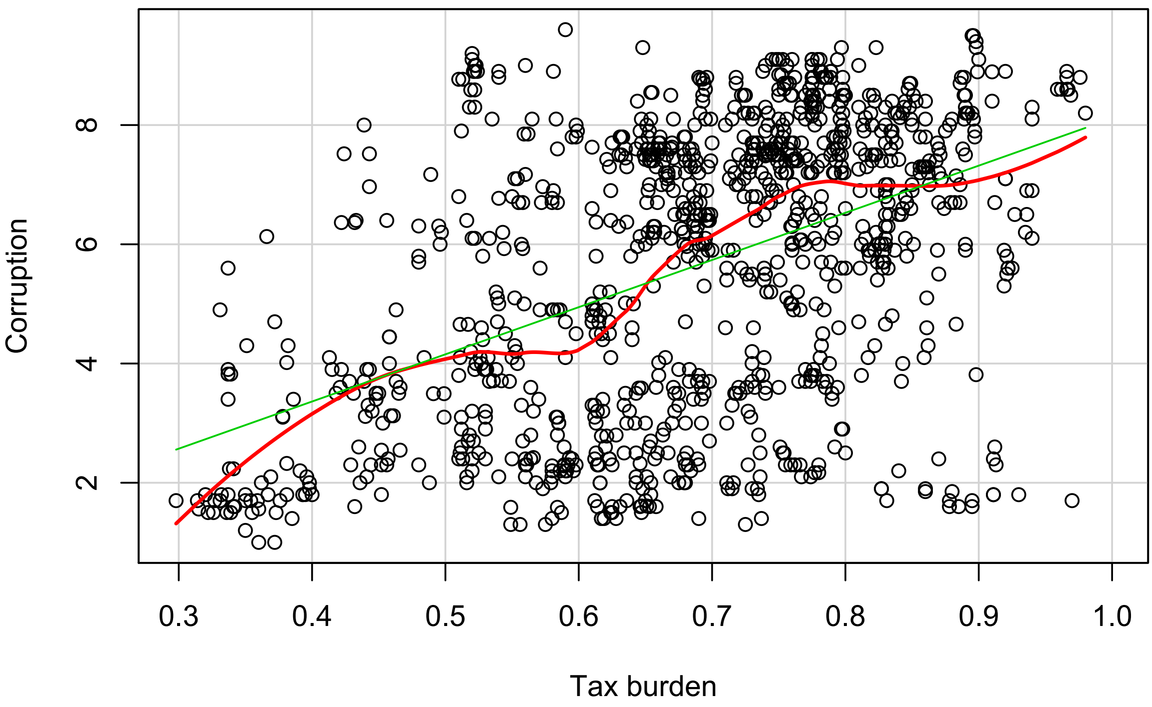

Figure 3. *Corruption with respect to Tax burden*

Table 1. *Descriptive statistics and data sources*

Variables	Mean	Standard deviation	Minimum	Maximum	Sources
- *TFP* (level at current PPPs, in million 2011 US dollars)	0.680	0.324	0.105	2.492	Feenstra *et al.* (2015), Penn World Table 9.0
- *Inflation* (price level of household consumption, US GDP in 2011=1)	0.615	0.311	0.143	1.713	———
- *Openness* (sum of shares of merchandises exports and imports in GDP, at current)	-0.042	0.162	-0.846	0.588	———
- *Corruption* (Corruption Perception Index)	5.633	2.373	1.000	9.600	Transparency International
- *Property rights*/100 (overall quality of legal framework)	0.561	0.242	0.100	0.950	The Heritage Foundation
- *Tax burden*/100 (% of tax revenue to GDP)	0.703	0.145	0.298	0.999	———
- *Government spending* (government consumption and all transfer)/100	0.663	0.219	0.100	0.993	———
- *Improved sanitation*/100, rural (facilities, % of rural population with access)	0.683	0.339	0.021	1.000	World Development Indicators, World Bank
- *Energy use*/10,000 (kg of oil equivalent per capita)	0.297	0.338	0.0009	2.276	———
- *Transport service* (% of commercial services	0.236	0.149	0.0007	0.880	———

exports)/100					
- *Electricity* (Electric power consumption (in kWh per capita)/10000)	1.030	3.786	1.030	55.578	———

2.2 Method

To estimate *Equation (1)*, the paper sequentially proceeds by using fixed effects estimation, Two-Stage Least Squares (2SLS), and Two-Stage System Generalized Method of Moments (System GMM). The choice of methods to be finally used is wisely reasoned by the classical homogeneity tests for panel data. Firstly, a Fisher type test for *poolability* is used, which unequivocally rejects the null hypothesis of pool data structure against the existence of fixed effects as alternative hypothesis – implying that countries in the sample exhibit distinctive features. Thus, the OLS estimators are not appropriate. Secondly, the paper performs the Hausman test to check whether those individual effects are random (H_0) or fixed (H_1). Again, the alternative hypothesis clearly prevails, saying that the estimations using the fixed effects estimators best fit the data. The Breush-Pagan test for individual and time effects, thirdly, confirms the previous results as it tests the pooled estimation (H_0) against the random effects model (H_1). Again, the hypothesis based on pooled estimations is clearly rejected. The outputs of those endogeneity tests therefore suggest the use of the fixed effects model estimators, which are more consistent with our data.

Our empirical analyses of *Equation 1* commence with the preliminary estimations. They results are summarized through *Regression 1* to *3* in *Table 2*. TFP is solely estimated with respect to corruption, except *Regression 3* that includes in addition the lagged dependent variable. Besides, in line with Isaksson (2007), several additional explanatory variables are used for controlling TFP (*Regressions 4* to *6* in *Table 2* and *Regression 7* to *12* in *Table 3*). With these regressions, it could be seen how robust and relevant is the initially measured impact of corruption on TFP in the preliminary estimations. On the other hand, one can also appraise the influence of TFP's determinant variables in the estimations. The estimation method is System GMM. *Table 4* includes regressions (*Regression 13* to *18*) attempting to take into account the influence of a relatively strong tax burden on TFP. These estimations include occasionally interaction variables generated between corruption and tax burden (denoted *Corruption*Tax burden*). They aim to capture both variables' indirect effect on the dependent variable. Likewise, the estimation technique is System GMM.

The use of 2SLS and System GMM methods is justified by the fact that their estimators are more qualified in controlling for joint endogeneity problem within regressors. In particular, the System GMM proposed by Blundell & Bond (1998) provides consistent estimators fulfilling the orthogonality conditions while allowing rigorous control over the instruments. In line with previous empirical work on corruption, we use country data relative to geographic latitude (Delavallade, 2006; or Gupta, Davoodi, & Alonso-Terme, 2002), ethnolinguistic fractionalization (Mauro, 1995), initial income of corruption (Gupta *et al.*, 2002), and protestant as percentage of population (Treisman, 2000) as instruments.

3. Empirical results

3.1 Preliminary estimations and estimated effects of TFP's determinants

Preliminary findings from *Table 2* suggest that corruption has a negative influence on TFP. The estimated coefficients remain both negative and statistically very significant with all the three estimation methods. This corroborates the first suspicions revealed with *Figure 1*. In *Regression 1*, using fixed effects estimators, the estimation suggests that a one-unit increase in corruption would reduce TFP by 0.02%, all things being equal. The R-squared measuring the general quality of the model is very low, meaning that there are other important explanatory variables in explaining TFP that are missing. *Regression 3* predicts a smaller negative effect of 0.005% when corruption increases in the same proportions. The Sargan test for over-identifying restrictions, with the null hypothesis that instruments are not correlated with the residuals, is robust to autocorrelation (*p*-value>0.05). The Arrelano–Bond tests for first (AR (1)) and second (AR (2)) order correlation in the first and second differenced residuals also turns out to be conclusive. The null hypothesis of the AR (1) and AR (2) is that the residual from the estimations is first-order, but not second-order correlated. The observed *p*-values for the test respectively equal 0.025 (<0.05) and 0.387 (>0.05).

Likewise, when one considers estimations including more explanatory variables (*Regression 4* in *Table 2)*, the findings also confirm that corruption constitutes a serious impediment to economic dynamism. The estimated coefficients of corruption are all negative while showing the best statistical significance standard. For instance, over the nine regressions carried out, it can be seen that the predicted drop in TFP is 0.01 % when corruption practices are increasing by one-unit. There results corroborate the preliminary estimations. Furthermore, the different Sargan tests argue for the validity of the instruments used. The Arellano–Bond and Wald tests are also all robust displaying their hoped *p*-values.

Concerning the other explanatory variables, the results overall seem consistent with textbook findings. Following their logic, we used variables related to tariff/non-tariff barriers, imports and openness in regressions in order to capture the "Creation-transmission and absorption of knowledge" dimension as TFP determinant. They all displayed positive and significant influence on TFP. *Openness* has been used as benchmark for this dimension as it presents the most satisfactory results. Its estimated coefficients stay positive and always significant throughout the estimations. In addition, it also has the advantage of being able to capture integration and competition as factors that may strongly encourage TFP growth (Maddison, 1999; 1997; Frankel & Romer, 1999).

Using *Improved sanitation* facilities access as percentage of rural population as *proxy* for health variable, our results clearly confirm the alleged positive relationship between health and TFP. Alternatively, we also introduce *Improved sanitation* facilities access as percentage of urban population and health expenditures as percentage of GDP in regressions. The estimated coefficients of the proxy overall has a positive impact on the dependent variable, however findings were not always as relevant as they are with our benchmark health variable. The Cole & Neumayer (2003) empirical study on 52 developing countries over 1965–1996 also finds a negative correlation between the proportion of undernourished and the workforce. Furthermore, the incidence of malaria and other waterborne diseases are also found to negatively affect both human capital and labour productivity.

In order to account for the institutional dimension, another highly influential factor for TFP, *Property rights* is included among the explanatory variables. Surprisingly, our findings suggest that better legal frameworks would rather tend to hamper TFP growth. By Ulubasoglu & Doucouliagos (2004), institutions embody rules and organs driving the production climate. Their researches conclude that democracy has a positive effect on TFP and human capital. However, a negative pattern clearly reappears with capital accumulation or labour force growth (see also Przeworski & Limongi, 1993; Isaksson, 2007).

Table 2. *Preliminary estimations of TFP with respect to corruption*

	Dependent variable: Total factor productivity (TFP)					
	Fixed effects	IV-2SLS	System GMM	System GMM		
	1	2	3	4	5	6
Corruption	-0.024*** (0.005)	-0.098*** (0.003)	-0.005*** (0.0009)	-0.012*** (0.002)	-0.008*** (0.001)	-0.012*** (0.002)
TFP_{t-1}	--	--	0.926*** (0.016)	0.915*** (0.014)	0.934*** (0.011)	0.917*** (0.013)
Openness	--	--	--	0.081*** (0.022)	0.073*** (0.020)	0.061** (0.019)
Property rights	--	--	--	-0.099*** (0.018)	-0.075*** (0.015)	-0.102*** (0.016)
Improved sanitation	--	--	--	0.044*** (0.013)	0.038** (0.012)	0.030** (0.009)
Energy use	--	--	--	-0.006 (0.004)	--	--
Electricity	--	--	--	--	0.0004 (0.002)	--
Transport service	--	--	--	--	--	0.024 (0.016)
Intercept	--	1.250*** (0.022)	--	--	--	--
R-squared	0.018	n.a.[a]	--	--	--	--
Sargan test (*p*-value)	--	--	1	1	1	1
AR (1) (*p*-value)	--	--	0.013	0.009	0.024	0.010
AR (2) (*p*-value)			0.338	0.811	0.894	0.779
Wald test, coefficients (*p*-value)	--	0.000	0.000	0.000	0.000	0.000
Wald test, dummies (*p*-value)	--	--	0.000	0.000	0.000	0.000
Number of observations	1088	1088	1984	1877	1606	1828

Notes. Robust standard errors of System GMM estimator are in parentheses. The superscripts ***,**, and *, represent statistical significance at 0.1, 1, and 5 % error level, respectively.
a: n.a. = not applicable; R-squared is not an appropriate measure of goodness of fit when using the estimator of 2SLS.

Furthermore, the variables that the proxy infrastructure factor (*Energy use*, *Electricity*, and *Transport service*) do not seem to have significant effect in explaining the dependent variable. Estimated coefficients are overall positive, but seldom statistically significant. For example, Aschauer (1989) showed that infrastructures have a high return in terms of private capital productivity. However that is possible only when their funding and management are more efficient (Aschauer & Lachler, 1998). Basing on 46 developing countries with 1970–1990 time span, their data highlight a positive effect from infrastructure when financed through lower current government spending, on the contrary of a funding causing further increase in public debt. That probably explains our results regarding infrastructures. In addition, note that more than 2/3 of countries of our sample are developing ones.

Table 3. *System GMM estimations of TFP including more control variables*

	Dependent variable: Total factor productivity (TFP)					
	System GMM					
	7	8	9	10	11	12
Corruption	-0.011***	-0.009***	-0.009***	-0.008***	-0.013***	-0.011***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
TFP_{t-1}	0.929***	0.921***	0.943***	0.942***	0.935***	0.923***
	(0.013)	(0.013)	(0.010)	(0.010)	(0.012)	(0.014)
Openness	0.083***	0.095***	0.076***	0.085***	0.061**	0.078**
	(0.023)	(0.028)	(0.021)	(0.023)	(0.020)	(0.025)
Property rights	-0.085***	-0.055**	-0.061***	-0.056**	-0.083***	-0.063***
	(0.017)	(0.019)	(0.015)	(0.017)	(0.014)	(0.017)
Improved sanitation	0.047***	0.043**	0.045***	0.042**	0.035***	0.038***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.010)	(0.011)
Energy use	0.006	0.003	--	--	--	--
	(0.007)	(0.007)				
Government spending	--	-0.036**	--	-0.022*	--	-0.034**
		(0.011)		(0.010)		(0.012)
Inflation	-0.032**	-0.043***	-0.037***	-0.044***	-0.033***	-0.045***
	(0.010)	(0.011)	(0.010)	(0.011)	(0.009)	(0.011)
Electricity	--	--	0.003	0.003	--	--
			(0.003)	(0.003)		
Transport service	--	--	--	--	0.031*	0.019
					(0.015)	(0.017)
Sargan test (*p*-value)	1	1	1	1	1	1
AR (1) (*p*-value)	0.011	0.007	0.033	0.020	0.007	0.010
AR (2) (*p*-value)	0.858	0.934	0.933	0.951	0.844	0.926
Wald test, coefficients (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000
Wald test, dummies (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000
Number of observations	1877	1846	1606	1586	1828	1803

Notes. Robust standard errors of System GMM estimator are in parentheses. The superscripts ***,**, and *, represent statistical significance at 0.1, 1, and 5 % error level, respectively.

In the end, our findings also confirm the common reasoning regarding the pernicious effect of inflation on economic performance (Romer, 1993; Lane, 1997). The estimated coefficients of *Inflation* in *Table 2* are constantly negative and highly statistically meaningful, which unequivocally points to the decline in TFP. Moreover, corruption has been partly identified as one of the causal chains of high inflation (Al-Marhubi, 2000). Given that corruption at the same time tends to increase transaction costs, we then hypothesize that together, they reinforce each other and seriously hinder TFP.

Government spending is also found to reduce TFP. However, this indicator includes the level of government consumption and all transfer payments. Such expenditures are not truly productive; they are even perceived as responsible to budget deficits and public debt, hence they would rather tend to reduce economic dynamism. Moreover, Mauro (1998) finds evidence of the influence of corruption in favouring some sectorial budgets more than others. Thus, corruption indeed seems to be associated to a fall in expenditures in health, education (*ibid.*, 1998), a fall in education, social protection, or health sectors spending (Delavallade, 2006), but to an increase in military, energy, or culture, order, or public services spending (*ibid.*, 2006). Dzhumashev (2014) empirically shows that expenditures related to social security are positively associated with corruption (*ibid.*, 2006).

3.2 The joint influence of corruption and tax burden on TFP

In *Table 4* the focus is on the role played by tax burden in the relationship between corruption and TFP. Again the analysis starts with a basic estimation (*Regression 13*) involving these variables of interest only. More specifically, TFP is controlled with respect to TFP_{t-1}, *Corruption*, *Tax burden*, and *Corruption*Tax burden*. The estimation results regarding the effect of corruption on TFP are robust and also claim that corrupt behaviors are contradictory to the objective of TFP growth. As in regressions launched before, the estimated coefficient of *Corruption* is negative and highly statistically significant. Furthermore, that of *Tax burden* also displays the same characteristics, saying that a relatively higher tax burden also likely causes a decline in TFP. However, when one considers *Corruption*Tax burden*, the interaction term between corruption and tax burden, it appears that the estimated coefficient is positive with highest statistical significance. The finding suggests that tax burden increases the negative impact of corruption on TFP, and *vice versa*. A scrutiny of *Regression 3* compared to *Regression 13* also gives credit to that argument. The difference between both estimations lies in the fact that the first regression ignores the influence of taxes on TFP, whereas the second one does not. As mentioned previously, *Regression 3* predicted a 0.005% drop in TFP when corruption level increase of 1-unit. However by including tax incidence in *Regression 13*, the estimated loss TFP provoked by corruption increases of 0.016%, which corresponds to an increase in its negative spillovers of 160%.

To put it simply, when the share of taxes in income increases, this is likely to aggravate corruption. Taxpayers merely tend to resort more and more to corruption or other fraudulent practices leading to tax evasion with its stabilizing effect in response to excessive tax increases. The foundations of this theory are in the Leviathan bureaucratic model developed by Buchanan & Brennan (1980), Tullock (1959), and Tiebout (1956). Leviathan government, which systematically seeks at increasing its size through public expenditures, applies disproportionate taxation in order to maximize tax revenue. With such expenditures, the Leviathan government intends to reinforce its power and gain in terms of prestige (Buchanan & Brennan, 1980). However, mobility and tax evasion considerably alleviate the expenditure-maximizing model reducing fiscal revenues. Recent developments in the literature also go in the same direction. Sanyal, Gang, & Goswami (2000) find that high tax rates result in smaller net revenue for the government. Furthermore, intensifying public sector audit and fine rate may have perverse impacts, thus reducing net revenues. This is even more likely when tax and fine rates are positively correlated with corruption (Goerke, 2008; Çule & Fulton, 2009). After testing how the incentive of tax officials towards bribery influences firm's tax evasion, Alm, Martinez-Vasquez, & McClennan (2016) conclude in the other way round that corruption is both economically and statistically significant in explaining the high levels of tax evasion. Tax evasion results in exacerbating corruption by creating additional opportunities for it (*ibid.*, 2016).

Table 4. *System GMM estimations of TFP including more control variables: The influence of tax burden*

	Dependent variable: Total factor productivity (TFP)						
	System GMM						
	13	14	15	16	17	18	19
Corruption	-0.016***	-0.009***	-0.014***	-0.018***	-0.017***	-0.010***	-0.017***
	(0.004)	(0.001)	(0.003)	(0.006)	(0.005)	(0.001)	(0.005)
TFP_{t-1}	0.951***	0.938***	0.942***	0.945***	0.942***	0.940***	0.948***
	(0.009)	(0.011)	(0.010)	(0.009)	(0.009)	(0.010)	(0.009)
Openness	--	0.078***	0.072***	0.077***	0.074***	0.058**	0.052**
		(0.022)	(0.019)	(0.020)	(0.020)	(0.019)	(0.018)
Property rights	--	-0.070***	-0.052**	-0.040**	-0.042**	-0.073***	-0.066***
		(0.017)	(0.017)	(0.014)	(0.014)	(0.015)	(0.015)
Improved sanitation	--	0.048***	0.038***	0.033*	0.037**	0.037***	0.029**
		(0.012)	(0.011)	(0.013)	(0.012)	(0.009)	(0.009)
Energy use	--	0.005	0.006	--	--	--	--
		(0.006)	(0.007)				
Inflation	--	-0.040***	-0.035***	-0.049**	-0.039***	-0.038***	-0.036**
		(0.010)	(0.010)	(0.020)	(0.012)	(0.009)	(0.015)
Tax burden	-0.137***	-0.045***	-0.091***	-0.111***	-0.121***	-0.046***	-0.099***
	(0.041)	(0.016)	(0.029)	(0.038)	(0.040)	(0.015)	(0.034)
*Corruption*Tax burden*	0.020***	--	0.010***	0.015***	0.015***	--	0.011**
	(0.006)		(0.004)	(0.007)	(0.006)		(0.005)
*Corruption*Inflation*	--	--	--	0.004**	--	--	0.002**
				(0.003)			(0.002)
Electricity	--	--	--	0.005	0.004	--	--
				(0.003)	(0.003)		
Transport service	--	--	--	--	--	0.030*	0.029*
						(0.016)	(0.014)
Sargan test (*p*-value)	1	1	1	1	1	1	1
AR (1) (*p*-value)	0.0045	0.008	0.003	0.011	0.012	0.008	0.003
AR (2) (*p*-value)	0.384	0.867	0.941	0.978	0.993	0.838	0.913
Wald test, coefficients (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald test, dummies (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Number of observations	1980	1877	1873	1602	1602	1828	1824

Notes. Robust standard errors of System GMM estimator are in parentheses. The superscripts ***,**, and *, represent statistical significance at 0.1, 1, and 5 % error level, respectively.

Returning to our model, the paper performs further regressions (*Regression 14* to *19*). They involve the use of several alternative determinants of TFP as control variables to test how robust is the tax burden's effect on corruption. In all the regression, the estimated coefficients of corruption and tax burden rigorously keep their negative sign while being highly significant, pointing once again to the detrimental effect of TFP. In particular, the test is further dug with the introduction of an additional interaction variable (*Corruption*Inflation*): that involving corruption and inflation. The estimated coefficient of the new interaction term is positive implying, just like with tax burden, that inflation to some extent contributes to corruption (Al-Marhubi, 2000). Both interaction variables, alongside with several determinants of TFP, are jointly used to control TFP in *Regressions 16* and *19*. Unambiguously, our finding still remains robust. Both Sargan and Arellano–Bond tests stay valid confirming the moment's conditions.

Furthermore, the paper also considers regional dummy variables in addition to independent variables to further extend the robustness test regarding our main findings. These variables are generated following the World Economic Outlook database (International Monetary Fund (IMF)) categorization. Variables used in the estimations are: *Emerging developing Asia*; *Sub-Saharan Africa*; *Advanced economies*; *Latin America–Caribbean*; *Middle-East–North Africa*; and *Euro area*. They are tested in *Regression 16*, which includes at this stage alongside with *Regression 19* a higher number of explanatory variables. The results of the robustness test are reported in *Appendix* (*Table 5*, *Regression 16.1* to *16.6*). We point out that the significance of variables slightly suffers because of the new control variables; however findings regarding the effects of corruption and tax burden on TFP remain valid; so for tests associated to regressions.

4. Conclusion

This study is an empirical analysis that examines the effects of corruption and tax burden on total factor productivity (TFP). It makes use of panel data of 90 countries worldwide over with span 1996-2014, and uses the corruption perception index (CPI) provided by *Transparency International.*

The estimation results unambiguously suggest that corruption, like tax burden, has a negative effect on TFP. When both variables alongside with the lagged dependent are used for controlling TFP, the finding suggests that one-unit increase in corruption standard deviation is associated to a decrease of 0.016% in TFP, and the increase in tax burden in the same proportion leads to a decline in TFP of 0.137% (*Table 4*, *Regression 13*). Furthermore, our findings highlight that a tax rate increase would result an aggravation of the negative impact of corruption on TFP. These findings remain robust to the introduction of TFP determinant variables over alternative regressions.

All in all, the paper sustains that TFP represents a narrow channel through which corruption highly undermines the economic prosperity of countries. To respond to the threat posed by corruption for the economies, decision-makers must pay due attention to fiscal policy in its design and implementation. The latter is a "double-edged sword" for countries regarding its intertwinement with corruption through shadow economy and other illegal practices deriving therefrom. Optimal taxation and efficient use of tax revenues both constitute an instrument for monitoring corruption efficiently; as such they encourage economic progress. Conversely, their mishandling generates more corruption and significantly affects their contribution to the service of the community.

For future studies, it might be interesting to empirically examine whether the impact of tax rate increases on TFP is conditional on how far countries are subject to tax evasion. Furthermore, a long-term comparison of the influence of corruption on the twin factors (human-physical capital) and TFP would be revealing too. It would help to understand whether the way corruption affects the dynamic of the economy changes over time – if so, then in which extent and which are the determinants. The implication of such an exercise could be that anticorruption efforts are oriented towards sectors on the basis of their sensitivity to corruption.

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Appendix:

Table 5. *Robustness test of the influence of corruption and tax burden on TFP*

	Dependent variable: Total factor productivity (TFP)						
	System GMM						
	16	16.1	16.2	16.3	16.4	16.5	16.6
Corruption	-0.018***	-0.019***	-0.019***	-0.019***	-0.020***	-0.021***	-0.021***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
TFP_{t-1}	0.945***	0.932***	0.928***	0.929***	0.924***	0.918***	0.914***
	(0.009)	(0.011)	(0.011)	(0.010)	(0.012)	(0.013)	(0.013)
Openness	0.077***	0.091***	0.095***	0.091***	0.097***	0.105***	0.107***
	(0.020)	(0.023)	(0.025)	(0.024)	(0.026)	(0.029)	(0.028)
Property rights	-0.040**	-0.042**	-0.045**	-0.046**	-0.044*	-0.046**	-0.047**
	(0.014)	(0.015)	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)
Improved sanitation	0.033*	0.038**	0.046***	0.042**	0.038**	0.041**	0.043**
	(0.013)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)
Inflation	-0.049**	-0.045*	-0.041*	-0.046*	-0.048*	-0.049*	-0.047*
	(0.020)	(0.020)	(0.019)	(0.020)	(0.026)	(0.021)	(0.022)
Tax burden	-0.111***	-0.123***	-0.119***	-0.112**	-0.114**	-0.117**	-0.118**
	(0.038)	(0.041)	(0.039)	(0.042)	(0.043)	(0.042)	(0.043)
*Corruption*Tax burden*	0.015***	0.017**	0.017**	0.017**	0.019**	0.019**	0.019**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
*Corruption*Inflation*	0.004**	0.001	0.001	0.001	0.002	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Electricity	0.005	0.005	0.005	0.004	0.004	0.004	0.005
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Emerging developing Asia	--	-0.022***	-0.020**	-0.018**	-0.026*	-0.017	-0.015
		(0.006)	(0.006)	(0.006)	(0.010)	(0.009)	(0.009)
Sub-Saharan Africa	--	--	0.008	0.009	0.001	0.013	0.014
			(0.006)	(0.006)	(0.008)	(0.009)	(0.010)
Advanced economies	--	--	--	0.010	0.005	0.013	0.011
				(0.007)	(0.009)	(0.009)	(0.011)
Latin America – Caribbean	--	--	--	--	-0.008	-0.0004	0.0003
					(0.008)	(0.008)	(0.008)
Middle-East – North Africa	--	--	--	--	--	0.019	0.021
						(0.012)	(0.012)
Euro area	--	--	--	--	--	--	0.003
							(0.006)
Sargan test (*p*-value)	1	1	1	1	1	1	1
AR (1) (*p*-value)	0.011	0.011	0.010	0.010	0.009	0.010	0.012
AR (2) (*p*-value)	0.978	0.994	0.988	0.999	0.989	0.978	0.976
Wald test, coefficients (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wald test, dummies (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Number of observations	1602	1602	1602	1602	1602	1602	1602

Notes. Robust standard errors of System GMM estimator are in parentheses. The superscripts ***,**, and *, represent statistical significance at 0.1, 1, and 5 % error level, respectively.

Figure 1.1. TFP vs Corruption: Emerging Developing Asia (EDA)

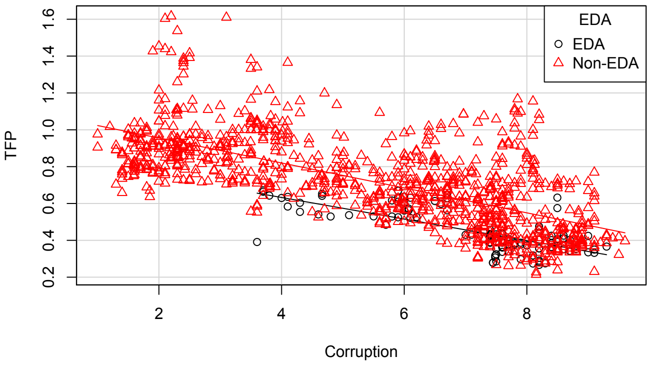

Figure 1.2. TFP vs Corruption: Sub-Saharan Africa (SSA)

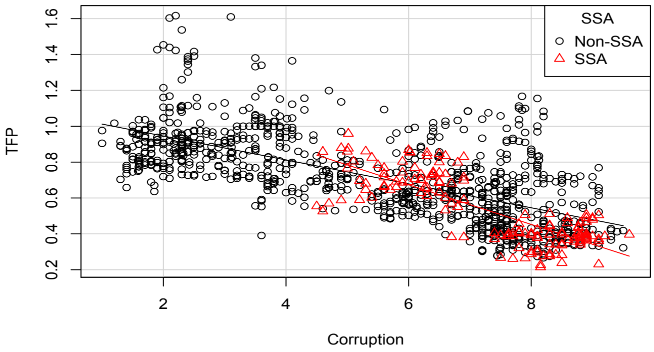

Figure 1.3. TFP vs Corruption: Advanced economies (AE)

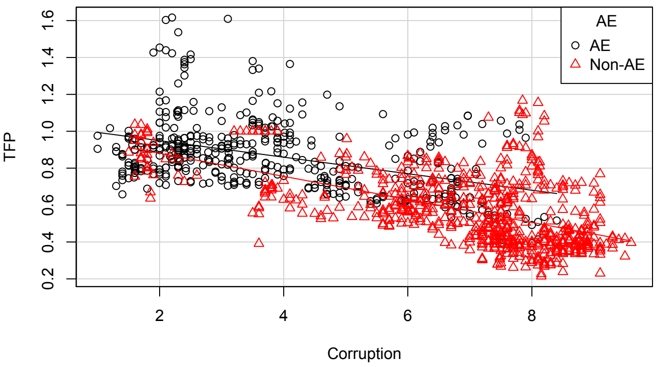

Figure 1.4. TFP vs Corruption: Latin America - Caribbean (LAC)

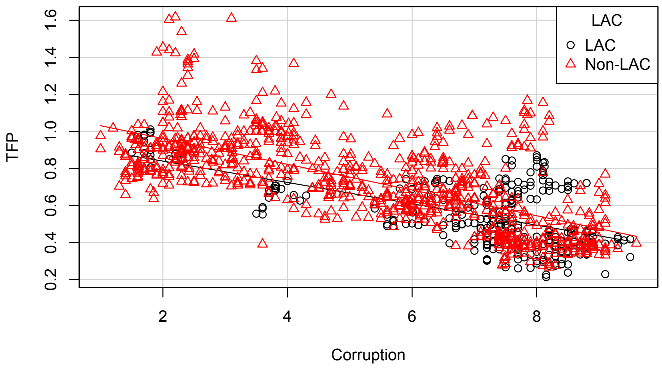

Figure 1.5. TFP vs Corruption: Middle-East - North Africa (MENA)

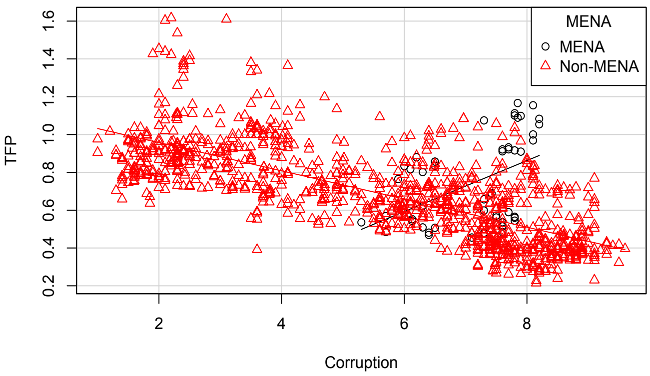

Figure 1.6. TFP vs Corruption: Euro area (EA)

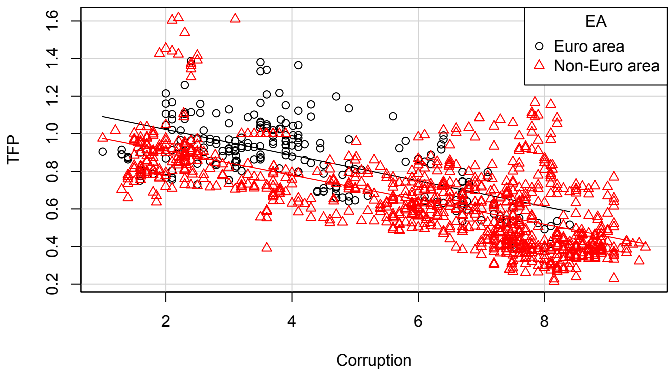

Figure 1.7. TFP vs Corruption: Emerg. market and developing economies

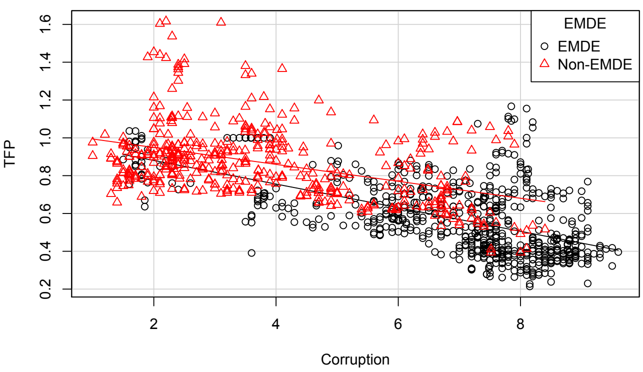

Figure 1.8. TFP vs Corruption: OECD

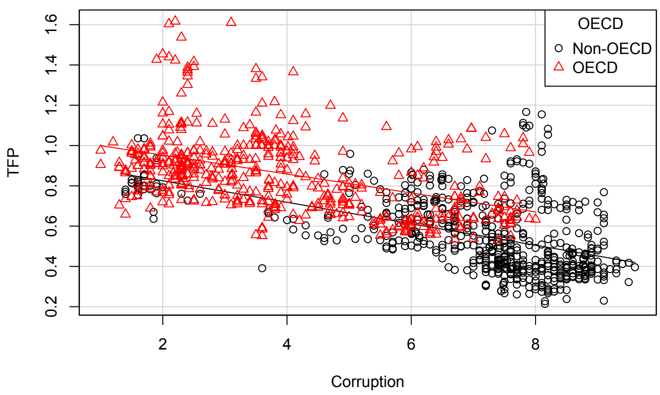

Table 6. *Unit-root test, Augmented Dickey-Fuller (AD-F) and Phillips-Perron (P-P) methods*

	Augmented Dickey-Fuller		Phillips-Perron	
Variable	DF statistics	*p*-value	DF statistics	*p*-value
TFP	-9.846	< 0.01	-31.332	0.01
Corruption	-10.778	< 0.01	-32.583	0.01
Openness	-10.035	< 0.01	-31.959	0.01
Property rights	-9.953	< 0.01	-31.645	0.01
Inflation	-10.821	< 0.01	-31.664	0.01
Tax burden	-10.104	< 0.01	-30.934	0.01
Government spending	-9.720	< 0.01	-29.000	0.01
Health expenditure	-10.977	< 0.01	-32.182	0.01
Improved sanitation	-10.886	< 0.01	-31.853	0.01
Electricity	-9.306	< 0.01	-30.809	0.01
Transport service	-10.045	< 0.01	-32.198	0.01
Energy use	-9.249	< 0.01	-30.904	0.01

Notes. For both methods, the null hypothesis (H_0) is that the series contain a unit root, against an alternative hypothesis (H_1) that at least one panel is stationary. H_0 is rejected under the condition that the *p*-value associated to DF statistics is smaller than the critical value 0.05. Here, in both cases, all series are rigorously stationary.

Table 7. *List of countries (90) in the sample*

Argentina, Australia, Austria, Bahrain, Barbados, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, Canada, Central African Republic, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Cyprus, Denmark, Dominican Republic, Egypt, Finland, France, Gabon, Germany, Greece, Guatemala, Honduras, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kuwait, Laos, Lesotho, Luxembourg, Malaysia, Malta, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Niger, Norway, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Republic of Korea, Romania, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Switzerland, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela.