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HOW DO INSTITUTIONS AFFECT CORRUPTION AND THE SHADOW ECONOMY?*

by

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Abstract: This paper analyzes a simple model that captures the relationship between institutional quality, the shadow economy and corruption. It shows that an improvement in institutional quality reduces the shadow economy and affects the corruption market. The exact relationship between corruption and institutional quality is, however, ambiguous and depends on the relative effectiveness of the institutional quality in the shadow and corruption markets. The predictions of the model are empirically tested—by means of Structural Equation Modelling that treats the shadow economy and the corruption market as latent variables—using data from OECD countries. The results show that an improvement in institutional quality reduces the shadow economy directly and corruption both directly and indirectly (through its effect on the shadow market).

Keywords: Corruption; Shadow Economies; OECD countries; Latent Variables; Structural Equation Modelling.
JEL classification: H10; O1; K49; C39.

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1 Introduction

> 'Just as it is impossible not to taste the honey (or the poison) that finds itself at the tip of the tongue, so it is impossible for a government servant not to eat up, at least, a bit of the king's revenue.'[1]

Corruption, by which we mean the abuse of public power for private gains, has always been present, in one form or another.[2] It is, in general, thought to be endemic, pervasive and a significant contributor to low economic growth, to distortionary investment and provision of public services, and to increase inequality to such an extent that international organizations like the World Bank have identified corruption as 'the single greatest obstacle to economic and social development' (World Bank, 2001). More recently, the World Bank has estimated that more than US$ 1 trillion is paid in bribes each year and that countries that tackle corruption, improve governance and the rule of law could increase per capita incomes by a staggering 400 percent (World Bank, 2004). One has to recognize, though, that this argument is not supported unanimously. Routine corruption may be efficiency enhancing. As Leff (1964) puts it: 'If the government has erred in its decision, the course made possible by corruption may well be the better one,' (p. 11). Corruption may also 'grease the wheels' in the rigid public administration. As Huntington (1968) notes: 'In terms of economic growth, the only thing worse than a society with a rigid, over-centralized, dishonest bureaucracy is one with a rigid, over-centralized, honest bureaucracy,' (p. 386).[3]

An important, and surprisingly, unexplored element of corruption is its relationship with the shadow economy. Clearly, corruption and shadow economy share a common characteristic: they are both, in general, illegal. The shadow economy it is widely believed, and existing estimates also confirm, to be both pervasive and significant.[4] It

[1]This quotation, attributed to Kautiliya (by R. P. Kangle), appears in Bardhan (1997, p. 1320).

[2]Corruption, in the common usage of the word, can mean different things in different contexts. For a discussion of some of the alternative denotations of the problem of corruption and its damaging consequences see the insightful survey by Bardhan (1997). See also Klitgaard (1988), and Rose-Ackerman (1999).

[3]Another efficiency argument in favour of corruption is to look upon it as the 'speed of money' which considerably reduces the slow-moving queues in public offices. For a criticism of this efficiency-enhancing view of corruption, see Tanzi (1998), Kaufmann and Wei (1999), and Rose-Ackerman (1999). Bardhan (1997), Jain (2001), and Aidt (2003) provide comprehensive accounts of the latest developments on corruption. See also Rose-Ackerman (1978, 1999), and Lambsdorff (1999). Kaufmann *et al.* (1999) provide a comprehensive account of empirical work on corruption.

[4]For the OECD countries—the subject of this paper —it is estimated, for instance, that for countries such as Greece and Italy the underground economies are almost one-third as large as the officially measured GNP. The smallest underground economies are estimated to be in Japan, US and Switzerland

is not difficult for one to be convinced that there are important reasons why policy makers should be concerned with the existence of the shadow economy; for example, erosion of tax and social security bases might cause significantly large budget deficits, and policies based on unreliable indicators of the size of the shadow economy may render these policies ineffective.

In understanding the relationship of corruption with the shadow economy it is important to understand what causes the shadow economy. With the risk of oversimplification, two schools of thought can be identified. One school of thought identifies high tax and social security burdens as the principal causes.[5] Economic agents, the story goes, are not willing to pay high taxes and so are driven out of the official economy.[6] The second school of thought identifies institutional quality—bureaucracy, regulatory discretion, rule of law, corruption and a weak legal system—as the main causes of driving economic agents underground. This view is based on the presumption that the Leviathan government is not (sufficiently) constitutionally constrained and, hence, uses its coercive powers to exploit the citizenry. The natural response of economic agents to this government behaviour is to go underground losing all publicly provided benefits. Clearly, then, there is a potential relationship between corruption (and the misbehavior of government in general) and the shadow economy. But what is the precise relationship? Is it that a high corruption leads to high unofficial economy and so they are complements, or to less, so they are substitutes? Theoretically, both types of relationship may stand. Indeed, Choi and Thum (2004) show that the shadow economy mitigates government-induced distortions leading to enhanced economic activities in the official sector, corruption and the shadow economy then being substitutes.[7] This is a view that seems to be in line with Rose-Ackerman (1997) who notes that 'going underground is a substitute for bribery, although sometimes firms bribe officials in order to avoid official taxes,' (p. 21). Alternatively, Friedman *et al.* (2000) show that corruption and the shadow economy are positively related. When faced with weak economic institutions entrepreneurs go under-

(countries that have traditionally relatively small public sectors and high tax morale), Schneider and Enste (2000, 2002). These estimates, however, need to be interpreted with some caution. See also footnote 39.

[5]See, for instance, among others, Tanzi (1982, 1999), Frey and Pommerehne (1984), Schneider (1994a,b, 1997), and Giles (1999). For a recent contribution that explores the extent to which moral sentiments may control shadow activities see Kanniainen *et al.* (2005).

[6]This view, it has to be said, is closely associated with the literature on tax evasion (a subset of underground economic activities). The seminal work on tax evasion is Allinghmam and Sandmo (1972). A thorough account of theoretical contributions can be found in Cowell (1990).

[7]The official market and the shadow economy are, however, complements. We address this in Section 2.

ground hiding their activities. As a consequence, tax revenues fall as well as the quality of public administration further reducing a firm's incentive to remain official. Using an inspector-tax payer model, Hindriks *et al.* (1998) also show that the shadow economy is a complement to corruption. This is because, in this case, the tax payer colludes with the inspector so the inspector underreports the tax liability of the tax payer in exchange for a bribe.

The empirical evidence, though limited, is in favor of corruption and the shadow economy being complements. Johnson *et al.*'s (1998) investigation of forty-nine countries in Latin America, the OECD, and the former Soviet Union block find a statistically significant positive relationship between the various measures of corruption and the shadow economy. As they note '... the relationship between the share of the unofficial economy and the rule of law (including corruption) is strong and consistent across seven measures. Countries with more corruption have higher shares of the unofficial economy,' (p. 391). Using data for 69 countries, Friedman *et al.* (2000) find evidence that 'more bureaucracy, greater corruption, and a weaker legal environment are all associated with a larger unofficial economy...', (p. 460).[8] They conclude that '.. poor institutions and a large unofficial economy go hand in hand,' (p. 460). Addressing the issue of causality they show, by using instruments such as long-standing linguistic fractionalization, the origins of the legal system, religious composition of the population and latitude, that the causal link runs from weak economic institutions to the size of the shadow economy. As they put it: '[the] results show there is an exogenous component of 'institutions' that is significantly correlated with the size of the unofficial economy', (p. 460).[9] Aside from the theoretical aspects of the relationship between corruption and the shadow economy, an attempt to empirically establish the relationship faces a difficulty; that corruption and the shadow economy do not lend themselves to measurement and so they are inherently latent variables.[10] A fruitful avenue to deal with this difficulty is the use of Structural Equation Modelling.[11] Though the fundamental importance of the quality of institutions

[8]They also find evidence that higher taxes are associated with a smaller underground sector.

[9]Focusing on regulation, Johnson *et al.* (1997) show that countries with more regulation of their economies tend to have a higher share of the unofficial economy in GDP.

[10]This measurement difficulty is to a great extent exacerbated by the lack and difficulty of a precise definition of the shadow economy. A working—and widely used—definition is 'all economic activities that contribute to the officially calculated (or observed) gross national product but are currently unregistered', Schneider and Enste (2000, p. 78). Clearly, this definition involves legal as well as illegal and corrupt activities.

[11]The Structural Equation Model was introduced to economics by Weck (1983), and Frey and Weck-Hannemann (1984) and latterly explored by Loayza (1996) and Giles (1999), among others, to measure the size of the shadow economy, Raiser *et al.* (2000) to investigate the institutional change in Eastern Europe, and Kuklys (2004) to measure welfare. Schneider and Enste (2000, 2002) offer a comprehensive

for combating corruption and the shadow economy is well recognized, to the best of our knowledge, no studies exist that attempt to articulate, and empirically estimate, the relationship treating the variables in question as inherently latent. This is the objective of this paper.

We set up a theoretical model which captures in a stark way the relationship between institutional quality, the shadow economy and corruption. The model relates to Shleifer and Vishny (1993) who analyze a bureaucracy issuing permits to perform some economic activity in exchange for bribes. They show that if the officials do not coordinate to extract bribes then the aggregate level of bribes will be too high from the point of view of the officials. The paper also relates to Bliss and Di Tella (1997) who show that corruption affects the number of firms in a free entry equilibrium and argue that the number of firms in the market place cannot be treated as exogenous. The model draws upon Choi and Thum (2004) with the key departure being in the explicit (but exogenous) specification of institutional quality.[12] The theoretical model shows that corruption and shadow economy are substitutes in the sense that the existence of the shadow economy reduces the propensity of officials to demand grafts from firms. It also shows that institutional quality, under a certain condition, may reduce both the magnitude of corruption and the size of the shadow economy. The predictions of the model are then tested and confirmed in a sample of 18 OECD countries.[13] To the best of our knowledge, this is the first paper that attempts to confirm a specific relationship—treating these variables as inherently latent—between institutional quality, corruption and shadow economy.

The organization of the paper is as follows. In Section 2 we introduce a simple model that investigates the relationship between institutional quality, corruption and the shadow economy. In Section 3 we present the Structural Equation Model used to confirm the hypothesized relationship between institutional quality, corruption and the shadow economy. We also derive the scores of the latent endogenous variables and so derive an index of corruption and shadow economy in the 18 OECD countries. In Section 4 we present and discuss the results. Finally, in Section 5 we conclude.

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account of studies on the hidden economy that have employed this approach. This approach has recently been used in Dreher *et al.* (2004) to derive an index of corruption based on around 100 countries.

[12] A word of clarification is in order here. This paper does not attempt to address the recent criticism regarding the extensive use of variables capturing the institutional quality that are based on surveys and suffer from 'artificial inertia', Rodrik (2004). Nevertheless, by treating the variables as latent we, to some extent, circumvent this problem.

[13] The small number of countries reflect, of course, data availability.

2 A simple model

The model is familiar from Choi and Thum (2004); the key departure is in the explicit specification of institutional quality. Corruption is defined, following Shleifer and Vishny (1993), 'as the sale by government officials of government property for personal gain' (p. 599). There is a continuum of firms, each of which is characterized by an 'earning ability' parameter θ. The individual characteristic θ—distributed with cumulative probability $F(\theta)$ with $F'(\theta) \geq 0$—is known to the firms but, importantly, not to the officials. There are two markets in this economy; an official, within which corrupt officials operate, and the shadow market. What distinguishes the former from the latter market is the *cost* of operation. In particular, in order to operate in the official market, firms must purchase a permit which is government property from an official who is corrupt at price denoted by m.[14] To avoid expropriation by government officials firms can enter the shadow market.[15] Entering the shadow market is, however, not cost free. The (expected) cost is the fine associated with the firm operating in the shadow economy. To minimize the possibility of getting caught firms typically scale down their degree of operation, an issue that we turn to shortly. Independent of their earning ability and market of operation, firms also incur fixed operating costs, such as the purchase of capital, denoted by $\rho > 0$.

Central to this paper is how institutional quality, in the presence of a free market equilibrium, affects both markets. It is not difficult for one to be convinced that the quality of the institution impacts differently in the two markets. Consider, for instance, the rule of law. One would expect, in this case, that an improvement in the rule of law reduces the incidence of illegal activities taking place in the two markets but it does so to different degrees since the nature of these activities are different (see footnote 15). To capture this it is assumed that institutional quality, denoted by e, improves the quality of the official market—denoted by $q(e)$,[16] with[17] $q'(e) > 0$—and also the quality of the shadow market, denoted by $\sigma(e)$, with $\sigma'(e) > 0$, but $q(e) \neq \sigma(e)$ and $q'(e) \neq \sigma'(e)$.[18]

[14]The officials so expropriate not only the firms but also the government property.

[15]It is implicitly assumed that there is no rent extraction in the shadow economy. If firms are caught operating in the shadow economy they are fined but the revenues are not observed and so cannot be expropriated by the corrupt officials.

[16]Another way to interpret this is as technology. The effectiveness of the institution in the two markets should be interpreted broadly to include, for instance, elements such as, among others, the complexity of the tax system and regulatory discretion. For a study on the effect of the complexity of the tax system on the size of the shadow economy see Schneider and Neck (1993).

[17]A derivative of a function of one variable is indicated by a prime and of many variables with a subscript.

[18]It is feasible to endogenize the quality of the institution e, but this will add no further insights to

There are two stages in the sequence of events. In the first stage, and for given institutional quality, the officials decide (anticipating the number of firms operating in the official market) what level of graft m to set in order to maximize graft revenues and in the second, for given level of graft, firms decide to either enter the official market, the shadow economy market or not to enter the markets at all.[19] To investigate the precise relationship between the corrupt and shadow markets and their relationship with the quality of the institutions, the strategy is to consider the behavior of public officials when the shadow market is not present and when it is. We start with the former.

2.1 Magnitude of corruption in the absence of the shadow market

A firm of earning ability θ that operates in the official economy has profits

$$\pi = \theta - \rho - mq(e) \ . \tag{1}$$

The last term in (1) captures the monetary cost of institutional quality to a firm with earnings ability θ. This cost is increasing in e reflecting the fact that an improvement in institutional quality results in the typical firm being caught engaging in corrupt activities.[20] Clearly, a marginal firm will enter the official market if and only if it realizes non-negative profits that is, following from (1), if and only if

$$\theta \geq \rho + mq(e) \equiv \underline{\theta} \ . \tag{2}$$

Condition (2), in turn, defines a cutoff level of θ, denoted by $\underline{\theta}$, such that all firms with earning ability above this will enter the official market by purchasing the permit at the cost of m. The proportion of firms, then, that will enter the market is $1 - F(\underline{\theta})$. For notational convenience, denote

$$G(\underline{\theta}) \equiv 1 - F(\underline{\theta}) \ , \tag{3}$$

with $G'(\underline{\theta}) \leq 0$ (to avoid uninteresting cases we take it throughout that $G' < 0$).

In the absence of a shadow economy, a corrupt official choosing m maximizes

$$R = mG(\underline{\theta}) \ , \tag{4}$$

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the paper.

[19] There is so commitment on the part of corrupt public officials: once announced, public officials cannot renege on the level of graft. This seems a natural assumption on the working of institutions in OECD countries.

[20] At first sight this specification might look peculiar. What we have in mind though is the fact that (an improvement of) institutional quality does not only affect corrupt officials but also affect the policing of firms caught engaging in corrupt activities.

with the necessary condition being

$$R_m = G + mG'q(e) = 0 \equiv T(m, e, \rho) \ . \tag{5}$$

Equation (5) implicitly defines the equilibrium level of graft $m^*(e, \rho)$. It is assumed that the second order condition, evaluated at $m^*(e, \rho)$, given by

$$T_m = q(e)\left(2G' - GG''/G'\right) < 0 \ , \tag{6}$$

is satisfied and so (5) has a unique solution. A property of (5) that will prove useful is that[21]

$$m^{*\prime}(e) = -T_e/T_m \ , \tag{7}$$

$$= -m^* q'(e)/q(e) < 0 \ , \tag{8}$$

and so an increase in institutional quality reduces the equilibrium level of graft demanded by the officials. Total equilibrium graft revenues, denoted by R^*, decrease with institutional quality. To see this, evaluate (4), using (5), and perturb to find

$$R'(e) = (m^*(e))^2 G'q'(e) < 0 \ . \tag{9}$$

That total equilibrium graft revenues decrease with institutional quality is intuitive. For institutional quality, e, does not, as an envelope property, affect graft revenues through $m^*(e)$ but only through $q(e)$; for given $m^*(e)$ an increase in e increases the cutoff level of $\underline{\theta}$ reducing the official market and thereby graft revenues.

It is also interesting to observe that an improvement in institutional quality does not affect the equilibrium *size* of the official market, denoted by H. To see this, notice that the size of the official market is given by $H(e) = G(\underline{\theta}(e))$. Differentiating H, and evaluating using (5) and (8), gives, as an envelope property, $H'(e) = 0$. That an increase in institutional quality reduces revenues (but leaves the official market unchanged) is perhaps not surprising. But it does serve as a useful benchmark to compare against the equilibrium outcomes in the presence of the shadow economy. This is what we turn to next.

2.2 Magnitude of corruption in the presence of the shadow market

Consider now an economy in which there is an underground sector. As noted previously, if a firm enters the shadow market it pays no graft but it requires to scale down the

[21] Throughout this subsection the dependence of the functions on ρ (being fixed) is suppressed.

level of the economic activity so as not to be detected. To capture this in a simple way, it is assumed that for a given $\sigma(e)$, the cost of entering the shadow economy is $\theta\sigma(e)$. Denoting variables pertaining to the shadow economy with a superscript s, profits are given by

$$\pi^s = \theta - \rho - \theta\sigma(e) \ . \tag{10}$$

It is also natural to assume that the cost of entering the shadow market is not too high that is, $\sigma(e) < 1$. Consider now the choice that a typical firm, with characteristic θ, faces. A simple comparison between (1) and (10) reveals that if $\theta \geq mq(e)/\sigma(e)$ then this firm participates in corruption, whereas if $\rho/(1-\sigma(e)) \leq \theta < mq(e)/\sigma(e)$ then it enters the shadow economy. With a sufficiently low $\theta < \rho/(1-\sigma(e))$ the firm makes, following (10), negative profits and hence ceases activity altogether.

Denoting total graft by R^s officials, choosing m, and anticipating the market equilibrium, maximize

$$R^s = mG\left(\frac{mq(e)}{\sigma(e)}\right) \ , \tag{11}$$

with necessary condition

$$R^s_m = G + mG'q(e)/\sigma(e) = 0 \equiv Z(m,e) \ , \tag{12}$$

which implicitly defines the optimal graft $m^{s*}(e)$ with, for later use,

$$m^{s*\prime} = -Z_e/Z_m \ , \tag{13}$$

$$= -m^{s*}e^{-1}\left(\varepsilon_q - \varepsilon_\sigma\right) \ , \tag{14}$$

where $\varepsilon_h \equiv h'(e)e/h > 0$ denotes the elasticity of $h = q, \sigma$ with respect to institutional quality e. Equation (14) reveals that the change in equilibrium graft, due to a change in institutional quality e, takes the opposite sign of $\varepsilon_q - \varepsilon_\sigma$. This is intuitive. Consider, for instance, $\varepsilon_q > \varepsilon_\sigma$. In this case corruption is easier to be detected, relative to the illegal activities taking place in the shadow market, and so the public officials respond to an increase in institutional quality by reducing the level of graft demanded, that is $m^{s*\prime} < 0$. Analogous reasoning applies to $\varepsilon_q < \varepsilon_\sigma$.

It is now straightforward to see that the equilibrium level of graft, denoted by R^{s*}, when the shadow economy exists is less than the level of graft when the shadow economy does not exist that is, $m^{s*}(e) < m^*(e)$. To see this evaluate (11) at the optimal level of graft $m^*(e)$ and then, starting from $m^*(e)$, consider a small change dm to find

$$dR^{s*} = G\left(\frac{\sigma(e)-1}{\sigma(e)}\right)dm < 0 \ , \tag{15}$$

with the inequality following upon $\sigma(e) < 1$. Clearly, then, since R^{s*} is strictly concave in m, $m^{s*}(e) < m^*(e)$ and so optimal graft under the existence of the shadow economy is smaller than without. This is intuitive. The shadow economy, for given institutional quality, imposes a constraint on the officials. When firms face a high graft, they have the option of going underground. The lower $m^{s*}(e)$, the more firms enter the official economy. Hence, when the shadow economy exists, corruption is lower and so the official economy is larger implying that the shadow market and the official economy are complements.[22]

What about total graft revenues? One would expect that these depend on the relative magnitudes of ε_q and ε_σ. Indeed, perturbing optimal graft R^{s*}, and evaluating at m^{s*} using (12), one obtains

$$R^{s*\prime} = \frac{(m^{s*})^2 q G'}{\sigma e}(\varepsilon_q - \varepsilon_\sigma) \ , \tag{16}$$

and so, with $G' < 0$, total graft revenues decrease (increase) in institutional quality when $\varepsilon_q > \varepsilon_\sigma$ ($\varepsilon_q < \varepsilon_\sigma$). The intuition of this is similar to the one given when the shadow economy was not present. An increase in institutional quality does not affect equilibrium revenues through m^{s*} but only via the cutoff level of θ thereby reducing the proportion of firms entering the official market.[23] Interestingly, however, improved institutional quality does not affect the size (number of firms) of the official market but it does affect the magnitude of graft revenues. This is for the same reason as that given above, but modified here to incorporate the shadow market. Specifically, with $\varepsilon_q > \varepsilon_\sigma$ ($\varepsilon_q < \varepsilon_\sigma$), the cutoff level of θ increases (decreases) thereby reducing (increasing) the number of firms entering in the official market. But this is not the end of the story. Following (14), to maintain maximum graft revenues, officials reduce (increase) the equilibrium level of graft undoing the change in the cutoff level of θ. Thus, overall, the size of the official market remains the same.

An increase in institutional quality, e, however, unambiguously reduces the size of the shadow economy. To see this notice first that, following the discussion in the preceding paragraph, with the equilibrium size of the official market being unaffected by institutional quality, there are no firms contemplating entering the official market after an improvement in institutional quality has taken place. What institutional quality affects, however, is the marginal firm that decides to stay in the shadow market or of

[22]This conclusion is also reached by Choi and Thum (2004), though they do not treat the role of institutional quality.

[23]It can be easily seen that with, as an envelope property, $m^{s*}(e)$ being unaffected by institutional quality, the threshold θ is increasing (decreasing) in e if and only if $\varepsilon_q > \varepsilon_\sigma$ ($\varepsilon_q < \varepsilon_\sigma$).

exiting the market completely. It is straightforward to show that the size of the shadow economy decreases with changes in institutional quality, e. To see this, denoting the proportion of firms entering the shadow economy by $S(e) = F(\rho/(1-\sigma(e)))$, we thus have $S'(e) = F'\rho\sigma'(e)/\left(1-\sigma(e)\right)^2 < 0$. Summarizing the preceding discussion:

Proposition 1 *Ceteris paribus, when $\varepsilon_q > \varepsilon_\sigma$ ($\varepsilon_q < \varepsilon_\sigma$), countries with better institutional quality are characterized by an official market with a low (high) magnitude of corruption. Moreover, while the size of the official market is independent of institutional quality, the size of the shadow economy reduces with an improvement in institutional quality.*

Proposition 1 emphasizes that the *size* of the shadow market unambiguously decreases with institutional quality, whereas the size of the corruption market remains unchanged. The exact relationship, however, between the *magnitude* of corruption and institutional quality is ambiguous as it depends on the relative effectiveness of the institutional quality in the two markets. If, for instance, institutions are more effective in combating corruption (and so more costly for the firms engaged in corrupt activities) relative to the shadow economy, in the sense that $\varepsilon_q > \varepsilon_\sigma$, then a further improvement in institutional quality reduces the magnitude of corruption. Officials, anticipating that the official market is less profitable for firms, reduce the level of graft demanded. But the opposite is also true. If the effectiveness of the institutions is biased towards combating the shadow economy, $\varepsilon_q < \varepsilon_\sigma$, then institutional quality may exacerbate corruption. The preceding analysis has emphasized that:

(i) the corruption and shadow markets are substitutes in the sense that the existence of the shadow market is associated with smaller levels of graft;

(ii) the effect of institutional quality on the shadow market is unambiguously negative whereas;

(iii) the effect of institutional quality on the magnitude of corruption is ambiguous and depends on the relative effectiveness of institutional quality on the two markets.

We now take the model to the data. We start with a description of the methodology used. As briefly touched upon in Section 1, the difficulty with the variables of corruption, the shadow economy and institutional quality is that they are inherently latent since they do not lend themselves easily to measurement. A fruitful and promising approach to estimating latent variables is to use Structural Equation Modelling.[24] This methodology

[24]Latent random variables represent unit-dimensional concepts. The observed variables or indicators of a latent variable contain random or systematic measurement errors but the latent variables are free of these errors. Latent variables correspond to hypothetical variables (constructs) that may vary in their degree of abstractness. We turn to this in the next Section.

is 'becoming a powerful approach' to these problems, Giles (1999, p. 372) and, applied to the present context, is outlined in the next Section.

3 A Structural Equation Model

Structural Equation Modelling allows a set of relationships between one or more independent variables and one or more dependent variables to be examined. Both independent and dependent variables can be either latent variables (factors) or measured variables (indicators). The underlying assumption is that the observed variables are perfectly correlated (or at least nearly so) with the latent variables that they measure.[25]

3.1 General model specification

It is instructive to provide the general specification of the model. A Structural Equation Model has the following form:

$$\boldsymbol{x} = \boldsymbol{\Lambda}_x \boldsymbol{\xi} + \boldsymbol{\delta} \,, \tag{17}$$

$$\boldsymbol{y} = \boldsymbol{\Lambda}_y \boldsymbol{\eta} + \boldsymbol{\epsilon} \,, \tag{18}$$

$$\boldsymbol{\eta} = \boldsymbol{B}\boldsymbol{\eta} + \boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\zeta} \,, \tag{19}$$

where $\boldsymbol{x} = (x_1, \ldots, x_q)'$ and $\boldsymbol{y} = (y_1, \ldots, y_p)'$ are the observed indicators of the latent factors $\boldsymbol{\xi} = (\xi_1, \ldots, \xi_n)'$ and $\boldsymbol{\eta} = (\eta_1, \ldots, \eta_m)'$ respectively. $\boldsymbol{\delta}$ (a $q \times 1$ vector) and $\boldsymbol{\epsilon}$ (a $p \times 1$ vector) are the measurement errors for $\boldsymbol{x}$ and $\boldsymbol{y}$ respectively. $\boldsymbol{\Lambda}_x$ is a $q \times n$ matrix of coefficients ('loadings') relating manifest exogenous variables $\boldsymbol{x}$ to exogenous latent variables $\boldsymbol{\xi}$ whereas $\boldsymbol{\Lambda}_y$ is a $p \times m$ matrix of coefficients relating manifest endogenous variables $\boldsymbol{y}$ to endogenous latent variables $\boldsymbol{\eta}$. $\boldsymbol{B}$ is the $m \times m$ coefficient matrix showing the influence of the latent endogenous variables on each other. $\boldsymbol{\Gamma}$ is the $m \times n$ coefficient matrix for the effects of $\boldsymbol{\xi}$ on $\boldsymbol{\eta}$. The model in (17) is called the exogenous measurement model, whereas the model in (18) is called the endogenous measurement model. The errors of measurement are assumed to be uncorrelated with $\boldsymbol{\xi}$ and $\boldsymbol{\zeta}$ and with each other. Also $E(\boldsymbol{\delta}) = \mathbf{0}_{q\times 1}$ and $E(\boldsymbol{\epsilon}) = \mathbf{0}_{p\times 1}$. To simplify matters $\boldsymbol{x}$, $\boldsymbol{y}$, $\boldsymbol{\xi}$ and $\boldsymbol{\eta}$ are written as deviations from their means, Bollen (1989). To incorporate cause indicators into the current model structure (see below) one needs to define each indicator, x_i, as equal to a latent variable ξ that is $\boldsymbol{x} = \boldsymbol{I}\boldsymbol{\xi}$,[26] where $\boldsymbol{x}$ is a vector of cause indicators.

[25] Of course all measures or abstract factors have far from perfect associations with the factor.

[26] The observed $\boldsymbol{x}$ variables, so, contain no measurement error.

The hypothesis of the model is that $\boldsymbol{\Sigma} = \boldsymbol{\Sigma}(\boldsymbol{\phi})$. Estimation is performed by choosing $\boldsymbol{\phi}$ (the vector that contains the model parameters) minimizing the maximum likelihood

$$F = \log|\boldsymbol{\Sigma}(\boldsymbol{\phi})| + tr\left\{\boldsymbol{S}\boldsymbol{\Sigma}^{-1}(\boldsymbol{\phi})\right\} - \log|\boldsymbol{S}| - (p+q) \ , \tag{20}$$

where $p+q$ is the number of measured variables.

Following equations (17) and (18), the implied covariance matrix is

$$\boldsymbol{\Sigma}(\boldsymbol{\phi}) = \begin{bmatrix} \boldsymbol{\Sigma}_{yy}(\boldsymbol{\phi}) & \boldsymbol{\Sigma}_{yx}(\boldsymbol{\phi}) \\ \boldsymbol{\Sigma}_{xy}(\boldsymbol{\phi}) & \boldsymbol{\Sigma}_{xx}(\boldsymbol{\phi}) \end{bmatrix} \ , \tag{21}$$

where,

$$\begin{aligned} \boldsymbol{\Sigma}_{yy}(\boldsymbol{\phi}) &= \boldsymbol{\Lambda}_y E(\boldsymbol{\eta}\boldsymbol{\eta}')\boldsymbol{\Lambda}_y' + \boldsymbol{\Theta}_\epsilon \ , & (22)\\ &= \boldsymbol{\Lambda}_y (\boldsymbol{I}-\boldsymbol{B})^{-1}(\boldsymbol{\Gamma}\boldsymbol{\Phi}\boldsymbol{\Gamma}' + \boldsymbol{\Psi})\left[(\boldsymbol{I}-\boldsymbol{B})^{-1}\right]'\boldsymbol{\Lambda}_y' + \boldsymbol{\Theta}_\epsilon \ , & (23)\\ \boldsymbol{\Sigma}_{yx}(\boldsymbol{\phi}) &= \boldsymbol{\Lambda}_y E(\boldsymbol{\eta}\boldsymbol{\xi}')\boldsymbol{\Lambda}_x' \ , & (24)\\ &= \boldsymbol{\Lambda}_y (\boldsymbol{I}-\boldsymbol{B})^{-1}\boldsymbol{\Gamma}\boldsymbol{\Phi}\boldsymbol{\Lambda}_x' \ , & (25)\\ \boldsymbol{\Sigma}_{xy}(\boldsymbol{\phi}) &= \boldsymbol{\Sigma}_{yx}'(\boldsymbol{\phi}) \ , & (26)\\ \boldsymbol{\Sigma}_{xx}(\boldsymbol{\phi}) &= \boldsymbol{\Lambda}_x\boldsymbol{\Phi}\boldsymbol{\Lambda}_x' + \boldsymbol{\Theta}_\delta & (27) \end{aligned}$$

where the equalities in (23) and (25) follow from substituting the reduced form of equation (19) that is, $\boldsymbol{\eta} = (\boldsymbol{I}-\boldsymbol{B})^{-1}(\boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\zeta})$. $\boldsymbol{\Theta}_\epsilon$ is the $p \times p$ covariance matrix of $\boldsymbol{\epsilon}$, $\boldsymbol{\Theta}_\delta$ is the $q \times q$ covariance matrix of $\boldsymbol{\delta}$, and $\boldsymbol{\Phi}$ is the $n \times n$ covariance matrix of the latent factors $\boldsymbol{\xi}$. $(\boldsymbol{I}-\boldsymbol{B})$ is required to be non-singular and so invertible.

Analysis of the covariance matrix of observed variables leads to unstandardized coefficients that depend upon the units in which the variables are scaled. To compare the effects of two or more variables on the same dependent variable when they have different units of measurement, the coefficients are standardized as follows

$$\hat{\lambda}_{ij}^s = \hat{\lambda}_{ij}\sqrt{\left(\frac{\hat{\sigma}_{jj}}{\sigma_{jj}}\right)} \ , \tag{28}$$

$$\hat{\beta}_{ij}^s = \hat{\beta}_{ij}\sqrt{\left(\frac{\hat{\sigma}_{jj}}{\sigma_{jj}}\right)} \ , \tag{29}$$

$$\hat{\gamma}_{ij}^s = \hat{\gamma}_{ij}\sqrt{\left(\frac{\hat{\sigma}_{jj}}{\sigma_{jj}}\right)} \ , \tag{30}$$

where the superscript s represents a standardized coefficient, i is the dependent variable, j is the independent, and $\hat{\sigma}_{ii}$, $\hat{\sigma}_{jj}$ are the model predicted variances of the i^{th} and j^{th}

variables. Once the hypothesized relationship between the variables has been identified and estimated, the latent variable scores η_j for each country $j = 1, \ldots J$ can be obtained following the procedure suggested by Jöreskog (2000).

The analysis outlined above allows us to decompose the effects of one variable on another into direct, indirect, and total effects.[27] Directs effects are the influences of one variable on another that are not mediated by any other variable. For non-recursive models as the present one, the direct, indirect and total effects of $\boldsymbol{\xi}$ on $\boldsymbol{\eta}$ (the variables of interest) are given by $\boldsymbol{\Gamma}$, $(\boldsymbol{I} - \boldsymbol{B})^{-1}\boldsymbol{\Gamma} - \boldsymbol{\Gamma}$, and $(\boldsymbol{I} - \boldsymbol{B})^{-1}\boldsymbol{\Gamma}$, respectively.[28]

3.2 Model specification

Figure 1 presents a representation of the system of simultaneous equations (path diagram)[29] of the hypothesized set of relationships that link the variables of interest, institutional quality, the shadow economy and corruption.

Figure 1 here.

Notice the direction of the arrows connecting the two constructs (factors), the shadow market[30] ('SHADOW'-η_1) and magnitude of corruption ('CORRUPTION'-η_2), to their indicators. These constructs predict the measured variables. The implication is that SHADOW is assessed using a country's tax revenue as a percentage of GDP ('TAX'-y_1), women labour participation rate ('LABOUR'-y_2) and the national currency in circulation relative to GDP ('CURRENCY'-y_3). The latent variable SHADOW is also predicated by the duration (in days) of starting up a business ('DURATION'-x_1), and an index indicating rigid regulation in the labor market ('FLEXIBILITY'-x_2). The magnitude of corruption, CORRUPTION is indicated by the Transparency International Corruption Perception Index ('TI'-y_4), and an index capturing procedural costs with meeting governments' requirements to start operating a business legally ('PROCEDURES'-y_5). These two endogenous latent variables are both predicated by an exogenous latent variable, capturing institutional quality ('QUALITY'-ξ_3). The exogenous latent variable

[27] Total and indirect effects are only defined under certain conditions. A sufficient condition for the total effects to exist is that the largest eigenvalue of the matrix $\boldsymbol{B}$ is less than one, Bollen (1989).

[28] For the effects of $\boldsymbol{\xi}$ on $\boldsymbol{y}$ and $\boldsymbol{x}$ as well as of $\boldsymbol{\eta}$ on $\boldsymbol{\eta}$, $\boldsymbol{y}$ and $\boldsymbol{x}$ see Bollen (1989), Table 8.9.

[29] It is common practise to represent the measured variables (indicators) by squares and the latent variables (factors) by circles. The hypothesized relationship between the variables are indicated by lines. Straight single-headed arrows represent one-way influences from the variable at the arrow base to the variable to which the arrow points.

[30] To avoid confusion, and where appropriate, we provide both the name of the variables and their symbolic representation in Subsection 3.1.

is indicated by a rule of law index ('LAW'-x_3) and an index of government effectiveness ('EFFECTIVENESS'-x_4).[31] Finally, the directional link between CORRUPTION and SHADOW tests the relationship between these two endogenous latent variables.[32] As predicted by the theoretical model, we expect a direct relation between QUALITY, SHADOW and CORRUPTION. We turn now to the results.

4 Results

4.1 Structural equation model estimates

To increase the number of observations the data have been averaged over the period 1998-2002. The sample, driven by data availability, covers 18 OECD countries. As noted in Subsection 3.1, prior to estimation the data are standardized.[33] Figure 2 presents the estimated coefficients. To derive the t-ratios for the indicator variables, one of the coefficients of the indicators must be normalized to 1. We have chosen to normalize the estimated parameters with respect to CURRENCY; this should be taken to mean higher currency circulation relative to GDP reflects a higher unofficial economy. The indicator variables are statistically significant at the 10 percent level at least, with higher TAX indicating a smaller shadow economy. This is in line with the evidence found by Friedman *et al.* (2000). The variable LABOUR has also the expected sign implying that a low participation rate, assuming constant labour force, indicates a high shadow economy. For the latent variable of corruption, CORRUPTION, we have normalized the estimated parameters with respect to TI (this should be taken to mean that high values of the Transparency International index reflects high corruption). The indicator variable of the latent CORRUPTION, PROCEDURES is significant at the 5 percent level. Turning now to the indicator of QUALITY, EFFECTIVENESS is positive—

[31] For the choice of the indicators of the latent variables we have been guided by the existing literature on corruption and shadow economy. The indicators for SHADOW, TAX and CURRENCY, are all variables that have been widely used, Schneider and Enste (2000). The indicator LABOUR follows from the fact that a decline in women labor force participation in the official economy can be seen, assuming constant labour force participation, as an indication of increased activity in the shadow economy, Schneider and Enste (2000). For CORRUPTION, TI is an obvious (perception based) indicator. Following Djankov *et al.* (2002), PROCEDURES (that cover direct costs of time associated with meeting government requirements that a start-up must bear before it can operate legally) should be correlated with CORRUPTION, too. The indicators of QUALITY seem to be obvious choices.

[32] From a theoretical point of view other variables could measure the underlying constructs equally well. In the empirical estimation other variables have been tried out. The final set of variables is the one that produces the best fit. Correlations between the error terms, where this increases model fit, have also been accounted for.

[33] All variables with their definitions and sources can be found in the Appendix. All estimations have been performed with LISREL® V. 8.5.4.

following the normalization of the estimated coefficient with respect to the variable LAW—and significant at the 1 percent level.

4.2 Structural equation model evaluation

To evaluate the model we make use of a number of statistics. The χ^2 statistic for testing the model against the alternative that the covariance matrix of the observed variables is unconstrained, where smaller values indicate a better fit is $\chi^2 = 14.75$ (with 16 degrees of freedom). In other words, a small χ^2 does not reject the null hypothesis that the model reproduces the covariance matrix. The χ^2 test of exact fit accepts the model at least at the five percent level of significance. The Root Mean Square Error of Approximation (RMSEA) accounts for the error of approximation in the population and has recently been recognized as one of the most informative criteria in covariance structure modelling, Steiger (1990). Expressed differently, the RMSEA measures how well the model fits based on the difference between the estimated and the actual covariance matrix (and degrees of freedom). The value of RMSEA is almost zero indicating a good fit.[34] Other indices providing evidence of an acceptable fit are the Goodness of Fit Index (GFI=0.84), the Adjusted Goodness of Fit Index (AGFI=0.55) and the Normed Fit Index (NFI=0.87). These indices range from zero to one, with values close to one indicating a better fit.[35] The squared multiple correlations for the structural equations are 0.51, and so moderately high, for SHADOW and, very high, 0.94 for CORRUPTION. Based on these goodness-of-fit statistics, we conclude that the model fits the data fairly well.

4.3 Direct and indirect effects

The path analysis in Figure 1, as noted in Section 3.1, allows us to distinguish three types of effects: direct, indirect and total. The direct effect is the influence of one variable on another that is unmediated by any other variable in the path diagram. The indirect effects of a variable are mediated by at least one intervening variable. The total effect of institutional quality captured by LAW on the latent variable SHADOW is $\gamma_{13} = -0.65$, and is significant at the 1 percent level. The interpretation of this is that a marginal improvement in institutional quality reduces the latent score of the shadow economy by

[34]Values of the RMSEA less than 0.05 indicate good fit, values as high as 0.08 represent reasonable fit, values from 0.08 to 0.10 indicate mediocre fit, and those greater than 0.10 indicate poor fit (MacCallum *et al.* 1996).

[35]These indices are based on comparison with a null model predicting all covariances to be zero. The NFI relates the chi-square of this null model to the chi-square of the actual model. The GFI and the AGFI compare the loss function of the null model with the loss function of the actual model, with AGFI adjusting for the complexity of the model.

0.65. The direct effect of QUALITY on the latent CORRUPTION (η_2) is $\gamma_{23} = -1.11$, and is significant at the 1 percent level, implying that a marginal increase in the rule of law reduces the magnitude of corruption by 1.11, as measured by the latent score. The estimated model, therefore, shows that an increase in institutional quality affects negatively both the shadow economy and corruption markets in OECD countries. The interpretation of this is that, in the sample of OECD countries, institutions seem to work better in combating corruption relative to underground economy. Turning now to the total effect of institutional quality, denoted by $T_{\eta_2\xi_3}$, on CORRUPTION is given by

$$T_{\eta_2\xi_3} = (1 - \beta_{21}\beta_{12})^{-1} (\beta_{21}\gamma_{13} + \gamma_{23}) \quad (31)$$

$$= -0.950 , \quad (32)$$

and is significant at the 1 percent level. Thus, a marginal increase in QUALITY reduces CORRUPTION by -0.950.[36]

The coefficient ($\beta_{21} = -0.25$) of the link between the two endogenous latent (CORRUPTION and SHADOW) variables is significant at 1 percent level implying that the existence of SHADOW reduces the magnitude of CORRUPTION. This, therefore, is consistent with the shadow economy and corruption being substitutes.

We turn now to deriving the scores for the latent variables for the countries in our sample. These latent scores allow us to provide a ranking of the shadow economy and the extent of corruption for the countries in our sample.

4.4 Latent scores (indices)

To derive the latent scores, as noted in Subsection 3.1, we adopt the procedure suggested by Jöreskog (2000). The results are presented in Table 1.[37]

Table 1 here.

As can be seen in Table 1, the country with the smallest shadow economy is Canada (with normalized index value 0), followed by Hungary (0.390), and Belgium (0.144). Among the countries in our sample, Mexico and the Slovak Republic have the largest unofficial sectors, with 1 and 0.440, respectively. In terms of corruption, Finland is the least corrupt country (with normalized index value 0) followed by New Zealand (0.081), and the UK (0.204). The most corrupt country is Mexico (with normalized index of 1),

[36]Notice that, as noted in Subsection 3.1, the total effects of $\boldsymbol{\xi}$ on $\boldsymbol{\eta}$ are defined if and only if the largest eigenvalue of the matrix of the estimated coefficients of the endogenous latent variables, B, is less than 1. In the estimated model the largest eigenvalue is 0.062 and so the total effects are defined.

[37]The results, of course, depend on the choice of the observed variables.

followed by the Slovak Republic (0.970), Poland (0.867), Czech Republic (0.853) and Greece (0.810).

One of course may still be not convinced of the accuracy of the indices and in particular with the index of CORRUPTION.[38] A natural additional test one could perform is the derivation of the correlation of the derived index of CORRUPTION with other existing indices. These correlations are reported in Table 2. This table reveals that the ranking of the index of CORRUPTION across the 18 OECD countries is highly correlated with the majority of the existing indices of CORRUPTION. It is worth noting that the index of corruption has the highest correlation (with correlation 0.9888) with the TI index, a widely used index.[39]

Table 2 here.

Taken together the estimates from the Structural Equation Model are consistent with the theoretical framework, that institutional quality affects negatively the shadow economy and corruption both directly and indirectly and that corruption and the shadow economy are substitutes.

5 Concluding remarks

This paper has taken a step towards understanding the relationship between institutional quality, corruption and the shadow market. It developed a simple model and confirmed existing results, associated with Choi and Thum (2004), that corruption and shadow markets are substitutes in the sense that the existence of the shadow market is associated with smaller levels of graft. It has also been shown that (i) the effect of institutional quality on the shadow market is unambiguously negative whereas, (ii) the effect of institutional quality on the magnitude of corruption is ambiguous and depends on the relative effectiveness of institutional quality on the two markets. These predictions were

[38]Since indices comparable to the index for SHADOW do not exist one should exercise caution in providing correlations between those indices and the index for SHADOW derived in this paper. This is because studies that are based on single latent models potentially are picking up aspects of corruption in their shadow economy measure.

[39]Two observations are in order here. Firstly, one might argue that the correlation of the derived index for CORRUPTION with TI is high because TI appears as an indicator of the latent variable of CORRUPTION. Yet, other indicators are *a priori* of equal importance. What the result here indicates is that *perceived* corruption—at least in the OECD countries—is highly correlated with *actual* corruption. This corroborates using the TI index as index for corruption in those countries. Secondly, one might be tempted to benchmark the indices SHADOW and CORRUPTION to existing estimates of the shadow economy and corruption. Though feasible, this benchmarking exercise suffers from a choice-bias, and is, in the present context, of limited use.

tested using data from 18 OECD countries. The empirical estimation confirmed the prediction that institutional quality reduces the shadow economy and corruption. The total effect of institutional quality on corruption was estimated to be negative and significant.

6 Appendix

6.1 Figures

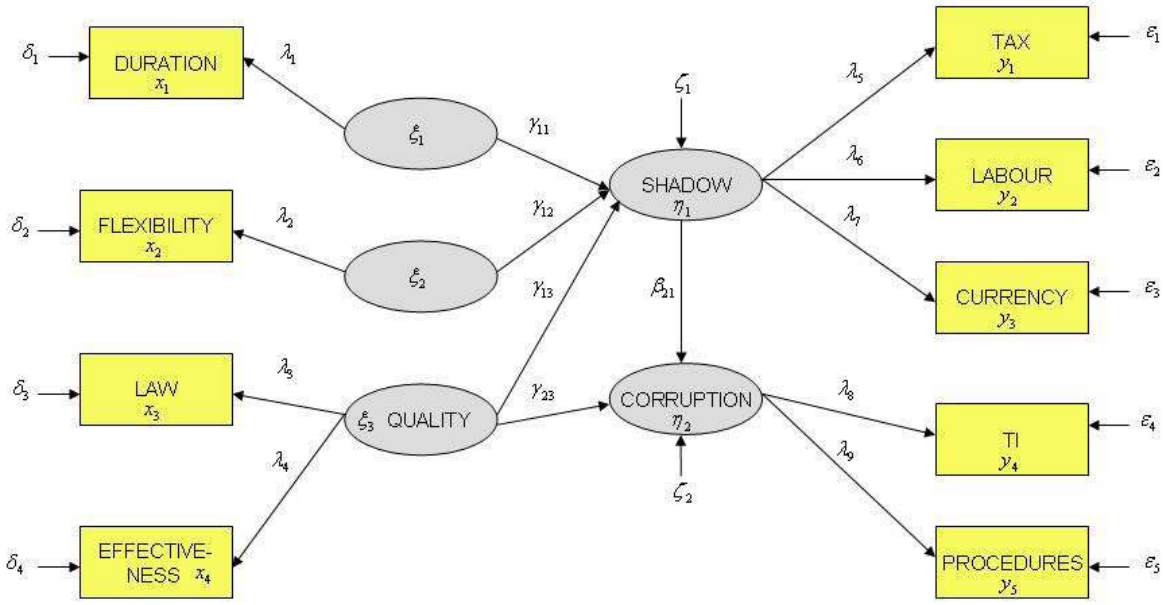
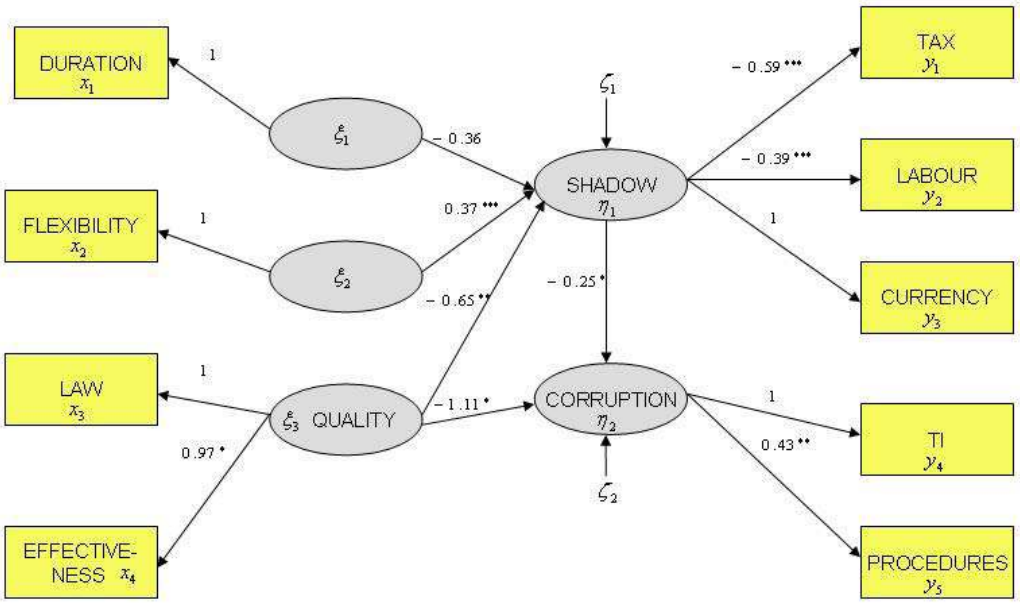


Figure 1: The path diagram



Levels of significance: 1 percent (*), 5 percent (**), 10 percent(***).

Figure 2: The model estimates

6.2 Tables

Table 1: **Indices of SHADOW and CORRUPTION.**

	SHADOW		**CORRUPTION**	
Country	*Index*	*Rank*	*Index*	*Rank*
Mexico	1	1	0	1
Slovak Rep.	0.440	2	0.970	2
Germany	0.243	3	0.374	10
Australia	0.235	4	0.208	15
Poland	0.223	5	0.867	3
Czech Rep.	0.209	6	0.853	4
Switzerland	0.207	7	0.216	14
New Zealand	0.201	8	0.081	17
Finland	0.200	9	0	18
United Kingdom	0.199	10	0.204	16
Italy	0.198	11	0.746	7
Greece	0.195	12	0.810	5
Portugal	0.178	13	0.570	8
Norway	0.163	14	0.222	13
Austria	0.160	15	0.342	11
Belgium	0.144	16	0.542	9
Hungary	0.139	17	0.748	6
Canada	0	18	0.300	12

Table 2: **Correlation of index of CORRUPTION with other indices.**

	Model	TI	ICRG	WVS	EBI	CI	CIM	CC
Model	1.0000							
TI	0.9888	1.0000						
ICRG	0.7177	0.7542	1.0000					
WVS	0.5953	0.5741	0.3356	1.0000				
EBI	0.8587	0.8590	0.5590	0.4201	1.0000			
CI	0.9719	0.9817	0.8028	0.6059	0.8410	1.0000		
CIM	0.7634	0.7434	0.3128	0.4570	0.6839	0.5683	1.0000	
CC	0.9734	0.9744	0.7361	0.5928	0.8727	0.6774	0.9576	1.0000

Note: TI is the Corruption Perception Index of Transparency International; ICRG is the International Country Risk Guide Corruption index; WVS is the World Value Survey (asking the question whether accepting a bribe is justifiable?); EBI is the Exporter Bribery Index of Friedman *et al.* (2000); CI is the Corruption Index of Friedman *et al.*

(2000); CIM is the Corruption Index based on the full model of 1997 of Dreher *et al.* (2004); and CC is the Control of Corruption of Kaufmann *et al.* (2003).

6.3 Data definitions

6.3.1 Indicators of the endogenous latent variables

TAX: Tax revenue in percent of GDP. Source: World Bank (2003), World Development Indicators.

LABOUR: Women activity rate. Source: International labour organization, LABORSTA Labour Statistics Database, extracted on 30/05/2004.

CURRENCY: Central Bank-Currency in Circulation in $US, divided by GDP. Source: Tompson Data Steam.

TI: Corruption Perception Index, Transparency International (2002). Scaling implies higher values of the index more CORRUPTION.

PROCEDURES: The costs associated with starting to operate legally a firm. Source: Djankov *et al.* (2002).

6.3.2 Indicators of the exogenous latent variables

DURATION: Starting a business, duration (days). Source: Djankov *et al.* (2002).

FLEXIBILITY: Flexibility of hiring index. Higher values represent more rigid regulation. Source: Doing Business, World Bank online Database.

LAW: Rule of law index. This index measures the extent to which agents have confidence in and abide by the rules of society. It refers to perceptions of the incidence of both violent and non-violent crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts. Measures the success of a society in developing an environment in which fair and predictable rules form the basis for social and economic interactions. Source: Kaufmann *et al.* (1999, 2003).

EFFECTIVENESS: This variable combines perceptions of the quality of public service provision, the quality of the bureaucracy, the competence of civil servants, the independence of the civil service from political pressures, and the credibility of the government's commitment to policies into a single grouping. The main focus is on 'inputs' required for the government to be able to produce and implement good policies. Source: Kaufmann *et al.* (1999, 2003).

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