Exploring the links between corruption and growth

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ABSTRACT:

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Exploring the links between corruption and growth

Andrew Hodge[*], Sriram Shankar, D.S. Prasada Rao, and Alan Duhs
School of Economics,
The University of Queensland
St. Lucia 4072 Australia

Abstract

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[*] Corresponding author: a.hodge@uq.edu.au. The authors thank Derek D. Headey for his comments and suggestions on earlier versions of this paper.

1. Introduction

The significance of corruption lies in its ability to influence the very roots of an economy. Corruption erodes property rights and so prospectively has significant consequences for both efficiency and equity. It strains political institutions and thus also threatens democracy and the social, political, and economic benefits attributed to it. It is often undertaken in secret and consequently complicates the nature of economic exchange.

The academic literature remains indefinite however about the impact of corruption on economic development.[1] Some early authors argued that corruption has the potential to improve efficiency and help growth. Leff (1964) and Huntington (1968), for example, viewed corruption as the necessary "grease" to lubricate the stiff wheels of rigid government administration. Similarly, other authors viewed corruption as working like piece-rate pay for bureaucrats, inducing a more efficient provision of government services. Lui (1985) demonstrates how bribes can minimize the costs associated with queuing and government labour, and consequently enhance the efficiency of public administration. Beck and Maher (1986) show a similar result when even under imperfect information the lowest cost firm is always the winner of a bidding procedure. More recently, Acemoglu and Verdier (1998) establish that in a situation where public officials are required to uphold property rights and enforce contractual arrangements, the costs associated with ensuring that public officials are not corrupt can be too high for the prevention of all corruption to be optimal.

The arguments above in favour of the efficiency effects of corruption are heavily dependent on static and partial perspectives of the context in which corruption is taking place (Bardhan, 1997; Kaufmann, 1997; Kaufmann and Wei, 1999; Seyf, 2001; Aidt, 2003).[2] For instance, Myrdal (1968) points out that instead of speeding up procedures, corrupt officials actually have an incentive to cause greater administrative delays in order to attract more bribes. Thus, "efficient corruption" arguments ignore the enormous degree of discretion that bureaucrats have.

Bureaucrats are able (and willing) to create, proliferate and reinterpret regulations in order to extract the maximum amount of corruption available (Kaufmann, 1997: 115).[3] Recent literature therefore views corruption as much more than a price mechanism (see Jain, 2001). Murphy, Shleifer and Vishny (1991), for example, argue that corruption causes the reallocation of talent away from entrepreneurial activities towards unproductive rent-seeking activities, as the most talented people compete for the greatest payoffs available within the economy. Accordingly, the effects of corruption are multifaceted and not as straightforward as many of the early authors portrayed.

Previous empirical research on corruption has commonly found that corruption impedes economic growth (Mauro, 1995, 1997, 1998; Tanzi, 1998; Kaufmann and Wei, 1999; Gupta *et al.*, 2000; Li *et al.*, 2000; Gupta *et al.*, 2001; Gupta *et al.*, 2002; Pellegrini and Gerlagh, 2004). Pellegrini and Gerlagh (2004: 429) note that 'it is a common finding in the literature that corruption hinders economic growth.' Svensson (2005: 39) adds that most, although not all, of the theoretical literature, as well as micro evidence, appear to suggest that corruption severely hampers development. At the firm level, Fisman and Svensson (2007) and Kimuyu (2007) both find corruption to have a negative effect on firm growth in Uganda and Kenya, respectively. Nonetheless, Svensson (2005) claims that there appears to be a mismatch between the micro and macro evidence, since within the cross-country setting corruption does not appear to affect growth. Svensson thus questions the validity of Mauro's (1995) findings, which stand as the seminal evidence of a direct causal relationship between corruption and growth, and provides also some tenuous opposing empirical evidence. Svensson (2005: 39) concludes that an unanswered puzzle remains in the macro context.

More recent empirical research largely supports Svensson's claim. Rock and Bonnett (2004) check the robustness of the negative effect of corruption on growth and investment using four different corruption measures. They find that corruption slows growth and/or reduces investment in most developing countries but in large East Asian newly industrialised economies (China, Indonesia, South Korea, Thailand, and Japan) corruption significantly promotes economic growth. On the other hand, Meon and Sekkat (2005) find a significant negative impact of corruption on growth. This impact is not only independent from corruption's effect on investment but also tends to worsen as the quality of governance deteriorates. Such results not only contradict the "greasing-the-wheels" view but support the contrary hypothesis that corruption "sands-the-wheels". These results, however, have been challenged by a recent study by Meon and Weill (2008). These authors analyse the interaction between aggregate efficiency, corruption, and different dimensions of governance and report a detrimental effect of corruption in economies with effective institutions but a positive association between corruption and efficiency in economies where institutions are ineffective. These results somewhat contradict Lambsdorff's (2003) findings that support the notion that corruption lowers the productivity of capital. However, Lambsdorff also found that once bureaucratic quality was included into the regressions, the influence exerted by corruption became insignificant.

Two further studies have sought to introduce nonlinearities into the corruption/growth relationship. Mendez and Sepulveda (2006) studied the effects of corruption on long-run growth by incorporating measures of political freedom as a key determinant of the relationship. They found evidence of a non-monotonic relationship between corruption and growth after controlling for several other economic variables. They show that corruption has a beneficial impact on long-run growth at low levels of incidence but is destructive at high levels, indicating that the growth-maximizing level of corruption is significantly greater than zero. This effect, however, was found to be robust only in a subsample of countries that have achieved a high degree of political freedom. Aidt, Dutta and Sena (2008) undertake a similar excerise but instead of splitting their sample of countries according to some chosen level of governance quality, they allow the data to determine if two regimes exist. They find two goverance regimes. In the regime with high quailty institutions, corruption is found to have a significant negatve impact on growth, while in the low quality instutional regime no corruption effect on growth is observed. In sum, these emprical studies show that relatively little is confidently known about the macroeconomic effects of corruption.

A second strand of economics literature has sought to determine the determinants of corruption (for example, Lederman *et al.*, 2005). The most comprehensive econometric analysis of the sources of corruption is a cross-sectional study from Treisman (2000).[4] This study tested a wide range of theoretical explanations of corruption and finds mostly factors that are difficult to change in the short to medium run as determinants of corruption. Specifically, Treisman found countries with long exposure to democracy, Protestant traditions, histories of British rule, more developed economies, and higher import were less corrupt (althought the effect of imports was considerably small), while federal states were found to be more corrupt.

In the main, subsequent empirical studies have focused on testing particular hypotheses by inserting a proxy for a specific variable into multiple regressions. Mostly, these studies have produced results that confirmed the theories that were tested. For example, several studies focused on the role of democracy (Chowdhury, 2004; Sung, 2004), others have investigated the role of decentralization and federalism (Fisman and Gatti, 2002; Arikan, 2004), and one on whether natural resources prevalence was a source of corruption (Leite and Weidmann, 1999).

Two recent reviews have sought to clarify which determinants of corruption are in fact robust. Treisman (2007) re-examines recent efforts to explain cross-country variation in corruption. Again he finds developed, long-estiablished democracies to be less corrupt. Countries with a free press, a high share of women in government, and a long record of trade openness are also found to be assocated with less corruption. On the other hand, countries are found to be more corrupt if they are dependent on fuel exports, intrusive regulations, and suffer from unpredictable inflation. Pellegrini and Gerlagh (2008) undertake a similar exercise using newly available data that cover a large sample of countries. These authors also find richer countries with long exposure to democracy to be less corrupt. Moreover, protestant traditions, political instability, press freedom, and public sector wages are also found to be assoicated with corruption. Factors such as common law system, ethnolinguistic fractionalisation and decentralisation which were previously found to have a significant assocation with corruption are no longer found to do so. Accordingly, the literature contains a fairly stout list of variables that explain the variation in corruption levels.

This paper addresses the nexus between corruption and growth, starting where Svensson (2005) finishes, with an aim of utilising the two current strands of the economic literature on corruption: namely, on the one side the effect of corruption on growth and on the other the determinants of corruption. The purpose of the paper is to model empirically the relationship between corruption and growth using cross-country panel data within a simultaneous equation system, and to thereby provide a complete and structured model of the various links between corruption and growth. This paper seeks to determine whether clear macro evidence of corruption's impact on growth can now be provided through explicit consideration of the impact of corruption on these transmission channels, and in turn of their impact on growth. Although the notion of indirect and direct effects of corruption on growth is not unique (see Mo, 2001; Pellegrini and Gerlagh, 2004) our approach is distinctly different from previous studies. The methodology utilised allows us to decompose the total effect of corruption on growth into its different components. The system estimates the sign and magnitude of each channel while controlling for other competing channels, the determinants of each channel and the determinants of corruption. Attention is also focused on testing the robustness of the results. We find that corruption hinders growth by reducing investment in physical capital and human capital levels, and by increasing political instability. On the other hand, corruption is found to promote growth by reducing government size and, less robustly, by increasing trade volume. The cumulative result of these partial effects provides an overall moderate negative impact of corruption on growth.

The paper is structured as follows. Section 2 outlines the transmission channels. Section 3 describes the specification of the empirical model and structure of the data set utilised in our study. Section 4 presents the empirical findings. Finally, Section 5 concludes, and notes implications for policy.

2. Transmission Channel Model

In a cross-country setting Svensson (2005) asserts that the relationship between corruption and growth is inconclusive. Potentially, this uncertainty could be explained by the failure of past studies to accurately account for the multifaceted nature of corruption. In this regard, the empirical studies of Mo (2001) and Pellegrini and Gerlagh (2004) are notable as both suggest that corruption has both direct and indirect effects on growth. We maintain a similar belief in the importance of transmission channels in demonstrating the significance and magnitude of the effect of corruption on growth. However, we employ a distinctly different empirical method and one that is more suitable for capturing the effect of these transmission channels. Before outlining this empirical method we must first clearly identify the potential transmission channels, as seen in the academic literature and elsewhere. The remainder of this section will outline these channels.

2.1 Transmission Channel I: Physical Capital Investment

Theoretical considerations and empirical evidence both suggest that corruption can influence economic growth through its impact on investment in physical capital (Romer, 1994; Mauro, 1995; Ades and Di Tella, 1997; Mauro, 1997; Wei, 2000; Jain, 2001). These studies suggest that corruption affects investment by adding uncertainty to the returns on investment activities. First, additional costs must be incurred when corruption is present in the economy. Entrepreneurs are forced to relinquish to corrupt officials a portion of the proceeds from their investment in order to gain access to their target markets. Thus, corruption tends to act as a tax on ex-post profits, diminishing the incentive for individuals to invest. Secondly, uncertainty arises due to the illegality and secrecy associated with corruption. This necessitates efforts to avoid detection and punishment, causing 'corruption to be more distortionary than [conventional] taxation' (Shleifer and Vishny, 1993: 612). Moreover, as Boycko, Shleifer and Vishny (1995) point out, agreements made through the use of bribery or other types of corruption are not enforceable by the law. Resolution of any disputes may be costly. Hence, through these factors corruption adds uncertainty with respect to the returns on investment activities, ultimately reducing the incentive for private individuals to invest. One should note, however, that plausibly corruption could positively influence investment via "greasing-the-wheel" effects discussed above. Here, some ambiguity would exist with respect to the corruption-investment relationship in the context of high regulation (something we test for later). Furthermore, many studies have shown physical capital investment to be one of the most robust determinants of economic growth (for example, Levine and Renelt, 1992).

2.2 Transmission Channel II: Human Capital

Corruption distorts investment in human capital via four mechanisms. First, corruption weakens tax administration and can lead to tax evasion and improper tax exemptions, which lower tax revenue and diminish the resources available for funding public provision of services, including education and health (Mauro, 1997; Johnson *et al.*, 1999; Gupta *et al.*, 2002). Secondly, corruption adds to the operating cost of government, and therefore reduces the resources available for other uses, again including human capital formation. Thirdly, corruption affects the *composition* of government expenditure (Mauro, 1997, 1998). Corrupt officials are more likely to choose to undertake types of government expenditure that allow them to collect undetected bribes. Expenditure on education and health provide less opportunity for rent taking. Basic education requires only basic technologies that can be provided by a relatively large number of suppliers (Mauro, 1998: 264). This diminishes the opportunities for corruption since prices cannot easily be surreptitiously over-quoted. Mauro (1998) and Gupta *et al.* (2000) both show empirically that corruption adversely affects the provision of education and health services. Finally, corruption can decrease the share of recurrent expenditure devoted to operations and maintenance (Tanzi and Davoodi, 1997). Such expenditures do not provide much opportunity for extractable rents and can act as a barrier towards obtaining these rents. In extreme cases, the quality of an economy's infrastructure may be intentionally reduced to the point where it needs to be totally rebuilt, thus again affording officials an opportunity to obtain rents through the tendering process. Moreover, in exchange for bribes, a corrupt system is more inclined to approve lower quality public procurement contracts (Mauro, 1997). This can lower the quality of education and health services and affects the ability of the state to improve educational attainment levels and overall health standards. Mankiw, Romer and Weil (1992), amongst others, have shown human capital to impact positively on growth.[5]

2.3 Transmission Channel III: Government Size

The potential impact of corruption on government size, as measured by the ratio of public consumption to GDP, is two-sided. On the one hand, corruption could encourage increased and inefficient allocation of government resources as corrupt officials seek to maximise their rent-extracting potential (Montinola and Jackman, 2002: 150). In the context of public investment, some empirical evidence has been found to support the notion that corruption increases public investment (Tanzi and Davoodi, 1997; Haque and Kneller, 2008), but these results are not conclusive (Mauro, 1997). On the other hand, corrupt officials could take an alternative route and maximise their rents by limiting the amount of public consumption expenditures. Either by underreporting public funds available for consumption or by redirecting public funds into private (often secretive, off-shore) bank accounts, corruption could potentially reduce government size. Elliot (1997) provides some preliminary evidence in support of this line of argument, in which she reports that the size of government budgets relative to GDP decreases with levels of corruption. Moreover, corruption has been found to reduce state revenue (Johnson *et al.*, 1999). Hence, it is unclear whether corrupt regimes would spend more or less than transparent administrations, so the issue requires empirical examination.[6] Previously, empirical studies have documented a negative impact of a larger government on growth (for example, Barro, 1991; Barro and Sala-i-Martin, 1995). These results have been theoretically explained by governments distorting savings (Barro, 1991), by bypassing the competitive process, or by the complete waste of government resources on unnecessary projects.

2.4 Transmission Channel IV: Trade Openness

The literature also suggests the potential for corruption to counteract movements towards greater trade openness. Krueger (1974) illustrates the rent-seeking activities created through quotas, clearly including corruption. Southgate *et al.* (2000) also contend that restrictions on trade, in the form of quotas or licenses, provide public officials substantial sources of rents.[7] Since the movement towards free trade would remove the means to extract at least some bribes, corrupt officials consequently have incentives to impede such movements. It is reasonable to suppose that existing domestic firms possess the sort of local knowledge needed to keep bribe expenses to a minimum (Southgate *et al.*, 2000: 2009). Potential foreign entrants lack this advantage and suffer disproportionately from corruption, which thereby acts as a brake on increased foreign investments. In contrast, the prevention of corruption could reduce trade volumes by increasing the international competitiveness of firms that engage in corruption. Beck, Mahler and Tschoegl (1991) found the Foreign Corrupt Practices Act of 1977 enacted in the United States, which prohibited US firms from engaging in corruption, limited these firms' ability to compete against firms from other countries who were able to engage in corruption. Similarly, Hines (1995) examined the impact of the 1977 legislation on US business activities with corruption-prone countries and found sharp decreases in US business activities. Such evidence supports the notion that corrupt firms are at some competitive advantage with respect to trade negotiations unless all countries play by the same rules. Thus, it is somewhat unclear whether corrupt economies will be more or less open to international trade, so the issue remains an open empirical question. In the main, as a result of increased market competition, technological transmissions, access to larger markets and other impacts, greater openness has been found to be associated with positive growth (for example, Wacziarg, 2001; Wacziarg and Welch, 2008).

2.5 Transmission Channel V: Political Instability

Corruption also challenges the popular legitimacy of political institutions and so can feed political instability and the violence that can flow from it (Mulloy, 1999 cited in Pellegrini and Gerlagh, 2004: 440). Corruption fuels perceptions of inequality and impropriety (Gupta *et al.*, 2002), and may encourage political instability through income polarisation (Mo, 2001: 74-75). Higher income inequality results in stronger incentives for the 'have nots' to engage in illegal or violent retaliation against 'the haves', especially if that wealth is thought to have been gained unfairly. Moreover, corruption attacks the foundations of democratic systems or what Friedman calls the social fabric, inexorably leading to political instability.[8] Empirically, instability is commonly found to reduce economic growth (for example, Barro, 1991; Alesina *et al.*, 1996; Caselli *et al.*, 1996; Easterly and Levine, 1997)

3. Estimation Framework

A model that links corruption to growth should ideally fulfil three criteria. First, it must have a theoretical foundation. Secondly, it must account for the various interactions between growth, the transmission channels, and corruption. Thus, it must identify and instrument for all endogenous variables in the model. Finally, the model should provide estimates of the magnitude by which corruption affects growth via the transmission channel, and the statistical significance of each channel. The empirical investigation undertaken in the rest of this paper seeks to satisfy these criteria through the use of the following econometric methodology. This method was first employed in a cross-country context by Tavares and Wacziarg (2001) to measure the effects of democracy on growth. It has subsequently been used by Wacziarg (2001) to investigate the impact of trade openness on growth, and by Lorentzen, McMillan and Wacziarg (2008) to examine the relationship between adult mortality and economic growth.[9] Here we apply this econometric methodology, which utilises three-stage least square estimation (3SLS), to investigate the relationship between corruption and economic growth.

3.1 The Structural Model Specification

The proposed econometric model consists of seven interrelated equations. It consist of an equation for growth of per capita income, one explaining the variation in corruption, and five channel equations, the latter capturing the influence of corruption on a set of growth determining variables. Following Tavares and Wacziarg (2001) we call this the *structural model*. Derived from economic theory, the structural model is set-up such that the channel variables are included in the growth regression, while the corruption index appears only in the channel equations. As such, it is intended that these channels exhaust the avenues by which corruption could influence growth (formal testing of the model's exhaustiveness is undertaken in the following section). Furthermore, the corruption equation is added to the model to address endogeneity issues relating to the potential simultaneous determination of corruption, growth and the channel variables as suggested both by theory and by past studies.

Formally, our model consists of $m = 1, \ldots, M$ structural equations, with $j = 1, ..., M$ endogenous variables and $k = 1, \ldots, K$ exogenous variables for $t = 1, \ldots, T$ time periods covering $i = 1, \ldots, N$ countries. The most general version of the structural model would consist of a set of $(T \times M)$ equations of the form:[10]

$$\begin{aligned}&\gamma_{11}^{tm} y_{i11} + \cdots + \gamma_{T1}^{tm} y_{iT1} + \cdots + \gamma_{1M}^{tm} y_{i1M} + \cdots + \gamma_{TM}^{tm} y_{iTM} + \\ &\delta_{11}^{tm} x_{i11} + \cdots + \delta_{T1}^{tm} x_{iT1} + \cdots + \delta_{1K}^{tm} x_{i1K} + \cdots + \delta_{TK}^{tm} x_{iTK} = \varepsilon_i^{tm}\end{aligned} \tag{1}$$

In its current form, the model is too general for the parameters to be identified. Accordingly, Tavares and Wacziarg (2001) impose the following restriction, which we too follow. First, all non-contemporary coefficients are restricted to zero ($\gamma_{sm}^{tm} = 0$ and $\delta_{sk}^{tm} = 0 \ \forall s \neq t$). Second, coefficients for each variable are constrained to be equal across time in each structural relationship ($\gamma_{tm}^{tm} = \gamma_{tm}^{sm}$ and $\delta_{sk}^{tm} = \delta_{tk}^{sm} \ \forall s$).[11] Third, in each structural equation the coefficient on the endogenous variable designated as the dependent variable for that structural equation is set equal to one. With these restrictions, the structural model is greatly simplified. For each set of T equations, the m = 1, ..., M structural equation can be written as:

$$\gamma_1^m \mathbf{y}_{i1} + \cdots + \mathbf{y}_{im} + \cdots + \gamma_M^m \mathbf{y}_{iM} + \delta_1^m \mathbf{x}_{i1} + \ldots + \delta_K^m \mathbf{x}_{iK} = \boldsymbol{\varepsilon}_i^m \tag{2}$$

where $\mathbf{y}_{ij}$, $\mathbf{x}_{ik}$, and $\boldsymbol{\varepsilon}_i^m$ are ($T \times 1$) vectors which stack the endogenous variables j = 1, ..., M, the exogenous variables k = 1, …, K and the errors m = 1, …, M over the T time periods. Hence, we can stack these equations over the M structural relationships:

$$(\boldsymbol{\Gamma} \otimes \mathbf{I_T})\mathbf{y}_i + (\boldsymbol{\Delta} \otimes \mathbf{I_T})\mathbf{x}_i = \boldsymbol{\varepsilon}_i \tag{3}$$

where:

$$\boldsymbol{\Gamma} = \begin{bmatrix} 1 & \gamma_2^1 & \cdots & \gamma_M^1 \\ \gamma_1^2 & 1 & \cdots & \gamma_M^2 \\ \vdots & \vdots & \ddots & \vdots \\ \gamma_1^M & \gamma_2^M & \cdots & 1 \end{bmatrix} \quad \boldsymbol{\Delta} = \begin{bmatrix} \delta_1^1 & \delta_2^1 & \cdots & \delta_K^1 \\ \delta_1^2 & \delta_2^2 & \cdots & \delta_K^2 \\ \vdots & \vdots & \ddots & \vdots \\ \delta_1^M & \delta_2^M & \cdots & \delta_K^M \end{bmatrix}$$

$$\mathbf{y}_i = \begin{bmatrix} \mathbf{y}_{i1} \\ \vdots \\ \vdots \\ \mathbf{y}_{iM} \end{bmatrix} \quad \mathbf{x}_i = \begin{bmatrix} \mathbf{x}_{i1} \\ \vdots \\ \vdots \\ \mathbf{x}_{iK} \end{bmatrix} \boldsymbol{\varepsilon}_i = \begin{bmatrix} \boldsymbol{\varepsilon}_i^1 \\ \vdots \\ \vdots \\ \boldsymbol{\varepsilon}_i^M \end{bmatrix}$$

The standard assumptions on the error vector also apply: $E(\boldsymbol{\varepsilon}_i) = \mathbf{0}$ and $E(\boldsymbol{\varepsilon}_i \boldsymbol{\varepsilon}_i') = \boldsymbol{\Sigma}$. Assuming that $\boldsymbol{\Gamma}$ is non-singular (the completeness condition) the reduced form of the model is:

$$\mathbf{y}_i = (\boldsymbol{\Pi} \otimes \mathbf{I_T})\mathbf{x}_i + \mathbf{v}_i \tag{4}$$

where $\mathbf{\Pi} = \mathbf{-\Gamma}^{-1}\mathbf{\Delta}$ and $\mathbf{v}_i = (\mathbf{\Gamma}^{-1} \otimes \mathbf{I_T})\boldsymbol{\varepsilon}_i$. The error term assumptions imply the reduced form error vector has the following properties: $E(\mathbf{v}_i) = \mathbf{0}$ and $E(\mathbf{v}_i\mathbf{v}_i') = \mathbf{\Omega}$ where $\mathbf{\Omega} = (\mathbf{\Gamma}^{-1} \otimes \mathbf{I_T})\mathbf{\Sigma}(\mathbf{\Gamma}^{-1} \otimes \mathbf{I_T})'$. Tavares and Wacziarg (2001) remark that an important features of this model is that by allowing the reduced form error terms to co-vary across time for a single relationship the model is effectively permitting a country specific effect that is independent from the right-hand side variables, an approach equivalent to the random effects model. Note, however, that the assumption that $E(\boldsymbol{\varepsilon}_i\boldsymbol{\varepsilon}_i') = \mathbf{\Sigma}$ implies that heteroskedasticity and spatial autocorrelation are not permitted within the model given that the covariance matrix of the full error vector does not depend on the country *i*.[12]

3.2 Specification, Identification and Estimation

To determine the specification of the system we follow two strategies developed by Tavares and Wacziarg (2001). The first strategy entails we specify a system based on *a priori* theoretical exclusions. This model is our benchmark model. In determining the benchmark specification we utilise the studies which were discussed in Section 2 as well as Tavares and Wacziarg (2001) and Wacziarg (2001). The specifications of the later two studies are themselves based upon existing empirical work, which we also referred to in the specification of our model (for example, Barro, 1991; Barro and Sala-i-Martin, 1995; Alesina and Wacziarg, 1998; Rodrik, 1998; Easterly and Levine, 2001; Durlauf *et al.*, 2005). Furthermore, in specifying the corruption equation we utilised prominent past studies which were outlined in Section 1 (for example, Treisman, 2000, 2007). The estimation of seven equations implies the need for a relatively wide set of exogenous variables. We selected a total of 20 exogenous variables with the aim of selecting a sufficiently wide set of variables to limit the scope for omitted variable bias. Accordingly, we selected a range of demographic, historical, cultural, geographic, and political variables. The full specification of the benchmark theoretical model is outlined in Table 1.

[Table 1]

Referring to Table 1, interest rests in three sets of estimates. Firstly, in the channel equations – equations (2) to (6) – we are interested in the estimated coefficient of corruption on the channel (γ_7^m for m = 2, ..., 6). These represent the direct effect of corruption on the channel variables. Secondly, in the growth equation, we are interested in the estimated coefficients on the channels variables (γ_j^1 for j = 2, ..., 6). Following from this, the product of the coefficient on corruption in the channel equation and the coefficient of the channel variable in the growth equation indicates the how corruption influences economic growth through the channel under consideration ($\gamma_7^m \times \gamma_j^1 \;\; \forall m = j$). The summation of these products then gives an indication of the combined effect of corruption on growth, accounting for any potential bi-directional influences from the different channels.

$$\text{Combined effect} = \sum_{j=2}^{6} (\gamma_7^j \times \gamma_j^1) \tag{5}$$

Thirdly, the inclusion of growth (γ_1^7) and some of the channel variables (γ_4^7 and γ_5^7) in the specification of the corruption equation gives rise to feedback within the system. Specifically, an initial change in corruption will cause changes in the channel variables and growth which feedback into the corruption equation, causing further change in corruption. Potentially this feedback could continue infinitely. Consequently, the calculation of the total effect of corruption on growth is more complicated compared to Tavares and Wacziarg (2001) system.[13]

To express the total effect in a formal manner we designate Δy_q^7 to be the change in corruption in round q.[14] Next, we allow each of the channel variables in the model to be denoted g = 2, ..., 6. Hence, we let Δy_q^g be the change in gth channel variable in round q, where:

$$\Delta y_q^g = \gamma_7^g \Delta y_q^7 \tag{6}$$

Next, we define Δy_q^1 to be the change in growth in round q, where:

$$\Delta y_q^1 = \sum_{g=2}^{6} \gamma_g^1 \Delta y_q^g \tag{7}$$

Note that Equation (7) collapses to Equation (5) when Δy_q^7 equals one. Finally, we can express the change in corruption in round (q+1) as:

$$\Delta y_{q+1}^7 = \gamma_1^7 \Delta y_q^1 + \sum_{g=2}^{6} \gamma_g^7 \Delta y_q^g \tag{8}$$

The total effect of corruption on growth can thus be expressed as:

$$\text{Total Effect} = \lim_{Q \to \infty} \sum_{q=1}^{Q} \Delta y_q^1 \tag{9}$$

The total effect will only converge if the feedback into corruption (Δy_q^7) gradually declines. For operational purposes we use the convergence criterion to terminate computation at some Q where at Q the $\Delta y_Q^7 < 1 \times 10^{-15}$. At this Q the feedback into the system is terminated and the total effect estimated. As demonstrated in Figure 1 we achieve convergence quite rapidly and usually within 10 to 20 iterations.

[Figure 1]

The benchmark model is estimated jointly using three-stage least squares. The 3SLS methodology implies that the exogenous variables in the system that are excluded from a given equation are used as instruments for the included endogenous variable(s) in that equation. In our model, the exclusion of leads and lags of exogenous variables ensures that the number of excluded instruments exceeds the number of included endogenous regressors, even when all contemporary exogenous and endogenous regressors are included in every channel equation.[15] Hence the system is identified by construction. Such instrumenting ensures the coefficient estimates are consistent. Moreover, 3SLS allows us to take account of the error correlations between equations, resulting in gains in efficiency. Furthermore, this method permits the computation of a single covariance matrix for all the estimates in the system. This allows inference on functions of parameters that may not necessarily belong to the same equation. For example, this allows us to make inferences on the combined effect of corruption on growth as defined in Equation (5).[16] Hence, by estimating our model using 3SLS we are able to combine features of instrumental variables, generalized least squares, and random effect models, whereby consistency is achieved through instrumentation, and efficiency is gained through appropriate weighting (Tavares and Wacziarg, 2001: 1351).[17]

The second strategy employed to specify the model involved an empirical specification search. Bias could be introduced into our estimates if the benchmark model excludes a relevant endogenous or exogenous variable from any one of our structural equations. Hence, to control for this possibility, the data is allowed to determine which variables should appear in each equation through an iteration process. At the first stage, the full system, which includes all contemporaneous variables on the right-hand side, was estimated using 3SLS. Naturally, this system will be over-specified and the number of exclusion restrictions is limited as a result. Accordingly, much is to be gained by reducing the system. The criteria for excluding variables from the various equations are twofold. First, we exclude variables that are statistically insignificant from zero. Second, we test the validity of these exclusions as a whole by computing a quasi-likelihood ratio (QLR) joint test based upon the minimum distance criterion from the reduced and initial models.[18] The exclusion of insignificant variables will modify the pattern of significance for the remaining coefficients. Consequently, we utilise the above criteria on subsequent iterations until we arrive at a specification whereby the included variables are chosen basis upon their individual statistical significance.

The empirical framework bears some similarity to that of Pellegrini and Gerlagh (2004), but nonetheless deviates from their structure in several ways. First, an extra transmission channel is added: government size. Secondly, each transmission channel includes a set of controls. Although Pellegrini and Gerlagh (2004) do include some control variables in their study, they do so only as a robustness test and the variables do not vary between channels nor include any cross dependence between the various channels. Thirdly, corruption is explained by political factors and environmental variables drawn from the theoretical and empirical work of previous authors.

Finally, the presence of endogenous variables in the channel equations implies that indirect channels effects can be controlled (for example, corruption could influence political instability, which affects government size, which in turn affects growth). Therefore, the model attempts to encompass as completely as possible the full relationship between corruption and growth.

3.3 Description of the Data

As previously outlined the chosen estimation methodology requires a relatively large set of variables.[19] Consequently, after eliminating countries with inadequate data coverage, this study covered a cross-section of 81 countries for the time period 1984-2005. This allowed a significantly wider coverage than was possible in the earlier studies of Mauro (58 countries) and Pellegrini and Gerlagh (48 countries).The data was constructed into a panel, split into two five-year periods (1984-1988 and 1989-1993) and two six-year periods (1994-1999 and 2000-2005).[20] As most of the variables entered in as five-year or six-year averages it is anticipated that the potential for measurement error and business cycle fluctuations influencing the results is minimised.

The main data on corruption were taken from the *Researcher's Dataset* constructed by Political Risk Services (ICRG, 2006). The degree of corruption is measured by an index constructed by the PRS group, published as part of their *International Country Risk Guide*. The ICRG corruption index varies from 0 to 6, with *higher* values indicating *higher* corruption.[21] The definition provided by the PRS (2006, p. 31) indicates that this corruption index intends to measure corruption in the political system and is 'concerned with actual or potential corruption in the form of excessive patronage, nepotism, job reservations, "favour-for-favours", secret party funding, and suspiciously close ties between politics and business.' The reasoning for this particular choice is three-fold. First, this index provides a measure of corruption over a substantial period of time. Due to data limitations, some of the earlier studies on corruption were forced to use measures of corruption that covered only a fraction of the time period under consideration. In this study the time period has been limited only to the period for which data on corruption is available. Second, the ICRG index appears to measure multiple dimensions of corruption, which is important given the difficulty of defining corruption. Third, although based on perceptions, in the context of corruption such measures are appropriate. Others to have used this data as a proxy for corruption include Knack and Keefer (1995); Tanzi and Davoodi (1997); Wei (2000); and Mendez and Speulveda (2006). We also test the sensitivity of our choice of corruption measure by re-estimating our model using the World Bank's Control of Corruption (COC) index.[22]

Table 2 presents the correlations between the main variables of interest. The correlations are all consistent with previous studies. Investment, human capital and openness all are found to have a positive correlation with growth. Furthermore, corruption, political instability, and government size (albeit minuscule) are all negatively correlated with per capita income growth. The third column details the correlation between corruption and the channel variables. All are found to be negatively correlated with corruption with the exception of political instability. The high correlations between corruption and the channel variables give some support to both the choice of channels and the simultaneous equation methodology undertaken in this study. If these correlations carry through to the model estimates they imply that corruption negatively affects growth through lower levels of investment, human capital, and openness and higher levels of political instability, while concurrently, positively affecting growth by reducing government size.[23] As will we find, this picture is not completely sustained once we have controlled for the interactions between these variables, other control variables, and potential endogeneity bias.

[Table 2]

4. Empirical Results

4.1 Benchmark Results

A summary of the effects of corruption on growth through the transmission channels for the full sample of 81 countries over the period 1984-2005 are presented in Table 3.[24] The second column of Table 3 presents the coefficients on corruption from the five channel equations. We find that corruption has significant negative impacts on investments in physical capital, human capital, and government consumption. Concurrently, corruption is found to have significant positive influences on political instability and trade volume. All of these coefficients are found to be significant at the 1 percent level. These results are broadly consistent with Pellegrini and Gerlagh (2004) and Mo (2001). The one exception is the positive influence of corruption on trade openness. This result could be explained by the differences in country and time coverage of our study (81 countries for the period 1984-2005) and that of Pellegrini and Gerlagh (48 countries for the period 1975-1996, although corruption is measured only for the period 1980-1985). However, one should note that our sensitivity analysis finds the openness channel to be the least robust of the channels, fluctuating in terms of statistical significance and changing sign on occasion.

[Table 3]

The third column of Table 3 details the estimated effect of different channels on growth. All of the channels enter with their expected sign and are consistent with the broad findings of past cross-country growth studies (for example, Barro and Sala-i-Martin, 1995; Sachs and Warner, 1997) and the transmission channel model of Tavares and Wacziarg (2001). The estimates suggest that higher levels of growth are achieved through increases in physical capital investment, human capital levels and trade openness, as well as decreases in political instability and government consumption. Investment in physical capital, human capital attainment, and political instability are found to be significant determinants of growth at a 99 percent confidence level, while government consumption is significant at a 97 percent confidence level and openness only at a 94 percent level.

The effects of corruption on growth through each of the channels are revealed in the last column of Table 3. These results suggest that corruption has detrimental effects on growth through physical capital investment, human capital, and political instability. At the same time, corruption is found to foster growth by increasing trade volumes and decreasing government consumption. These combined effects are all significant at a 99 percent confidence level, with the exceptions of government consumption (97 percent) and openness (92 percent). The largest effects are through investment (which is consistent with Pellegrini and Gerlagh) and political instability (which is consistent with Mo) channels. The combined effect of corruption on growth is found to be negative and statistically significance from zero at a 99 percent confidence level.[25] This combined effect indicates that an initial one standard deviation (1.382) increase in the corruption index brings about an approximate decrease of annual growth in GDP per capita of 0.39996 percentage points.[26] After accounting for the feedback effects, we find that the model converges to a total effect of -0.3409, implying that a one standard deviation increase in the corruption index leads to a 0.4711 percentage point decrease in economic growth. This result is smaller than Pellegrini and Gerlagh (2004: 434) benchmark result: they find a decrease in the corruption level of one standard deviation increases economic growth by approximately 1.05 percentage points per year. This is unsurprising since Pellegrini and Gerlagh do not find any positive effects of corruption on growth via the transmission channels they estimated. Overall, the total effect of corruption on growth is negative and economically moderate. The origins of this effect are empirical explained by the varying effects of the respective transmission channels.

4.2 Robustness Testing

In this section we test the robustness of our benchmark model to changes in the model specification, sample coverage, and estimation method. Moreover, we test for whether our model exhaustively captures the total effect of corruption on economic growth. To conserve space we report only the combined effects of corruption on the channels and the total effect under the different models. These results are then compared to the benchmark model (which is included in all the tables).

4.2.1 Model Specification and Alterations

Plainly, our estimates of the total effect of corruption on growth could be influenced by the degree of feedback specified in the model. In the benchmark model feedback is permitted via the inclusion of growth, openness, and political instability in the corruption equation. Table 4 presents several modifications to the degree of feedback permitted in the model. Firstly, we estimate the model with no feedback: that is, we drop growth, openness, and political instability as determinants of corruption. This is case the combined effect is the total effect. Even with no feedback, the total effect is still found to be negative and only slightly smaller than the base model result. Next we include growth in the corruption equation as the only source of feedback, a specification identical to Wacziarg (2001). Here we find the feedback to be small, with convergence achieved after only 8 iterations. Following this, we include all the channel variables in the corruption equation. Unsurprisingly, the total effect is greater than estimated in the base model. Finally, we estimate the model permitting feedback via the corruption equation and each of the channel equations by including economic growth in all the channels and all the endogenous variables in the corruption equation. Convergence is again achieved and the total effect of corruption of growth is still found to be negative and economically moderate. Thus our base model does seem to be robust to the degree of feedback permitted. Figure 1 illustrates that the base model estimate is roughly midway between models that permit no feedback and those that permit numerous avenues. If anything, the total effect of corruption on growth estimated using the base model is rather a conservative estimate, reinforcing our confidence in the benchmark specification.

[Table 4]

Table 5 presents the results from the empirical specification search outlined in Section 3.2. We present the estimates at each stage. At all iterations the signs of all the channels are consistent with the benchmark model. The total effect is reduced slightly compared to the benchmark model but remains statistically significant at a 95 percent confidence level once we arrive at the last iteration. The QLR statistics illustrate that we cannot reject the null hypothesis that the excluded variables are jointly insignificant indicating that the exclusions of the variables are statistically justifiable at each stage. Notably, a majority of the determinants in the benchmark model survive the specification search. Approximately 73.25 percent of the variables appearing in the benchmark model also appear as significant determinants in the systematic search specification. Focusing on the last column of Table 5 we find that the significance of all the channels has been reduced slightly, with the exception of openness which has become more significant. Investment continues to be the dominant channel. On the whole, the benchmark specification appears robust to the empirical specification search. Corruption maintains its effect on the channels and all the channels maintain their effects on growth. Accordingly, the total effect continues to indicate a negative effect of corruption on growth.

[Table 5]

Table 6 presents the results of several modifications to the benchmark model. First, we allow the intercepts of each relationship to vary across time. The channels are robust to this specification change with the exception of trade openness. While the sign on openness is maintained, the effect is no longer significant even at a 90 percent level. This is a consequence of both the effect of corruption on openness and the effect of openness on growth decreasing in significance. The magnitude of the effect of investment, human capital and political instability all increase in comparison to the benchmark leading to an increase in the negative total effect, which has also increased in statistical significance.

Tavares and Wacziarg (2001: 1361) indicate that the results may be influenced by the effect of time-invariant region-specific effects not accounted for within the estimation method. Consequently, regional dummies for OECD member-countries, Latin America, Sub-Saharan Africa, and East Asia, are added to the specification in the fourth, fifth and sixth columns of Table 6 to attempt to control for these effects. We begin by adding these regional dummies into the channel equations only. All of the signs of the channels are preserved and the magnitudes of the effects are diminished.[27] The statistical significance of the trade openness channel is again reduced and is no longer significant. Moreover, the government size channel is now marginally insignificant at a 90 percent confidence level. Next we added the region dummies to the corruption equation as well. Similar results are again obtained. Notably, government size and trade openness are again found to be insignificant. Finally, we also add the regional dummies to the growth equation. Very similar results are again obtained. The most notable difference is a change in sign of the government size channel; however, this channel is highly insignificant.

The log of initial per capita income is included as a control variable for every equation. Given the moderate correlation between corruption and income levels (-0.665), we exclude the income variable from each of the channel equations to determine any sensitivity. We can expect the exclusion of income to lead to an increase in the overall effect of corruption on growth as corruption stands to capture some of the effect previously attributed to income. This is indeed the case, with the total effect almost doubling in magnitude. The signs of all the channels are preserved. Openness and government consumption are found to be insignificant as a result of reductions in significance of these variables in the growth regression.

To control for possible endogeneity between growth and corruption, the benchmark model includes growth as a control variable in the corruption equation. This effect is found to be negative, as expected, and significant.[28] As past studies have rightly highlighted, this indicates that endogeneity does indeed need to be control for in the context of corruption-growth, reinforcing the desirability of the methodology we have utilised in this study. One may wonder whether similar endogeneity issues should be accounted for between the channel variables and growth. Consequently, we test for potential bias in our benchmark model by adding growth as a control variable into all of our channel equations. The final column of Table 6 presents the results of modification. We find that our benchmark model is robust to the inclusion of growth in all the channel equations. The signs of all the channels are preserved. The only major change is that human capital channel all but disappears, casting some doubt on its robustness. The total effect is slightly reduced, but remains highly significant.

[Table 6]

In a similar vein, one may question the possible endogeneity between corruption and the channel equations. In specifying the corruption equation in the benchmark model we followed past studies which have found openness and political instability to be determinants of corruption. It is possible that investment, human capital, and/or government size may also share a bi-directional relationship with corruption. We test the sensitivity of our model to this possibility by including all channel variables as determinants of the corruption equation. The fifth column of Table 4 presents the results of this modification. The benchmark model is found to be robust to this change. All the channels maintain their expected signs and all are statistically significant. The combined effect is very similar to the benchmark model and preserves its high statistical significance. Given the increased degree of feedback in the model, it is unsurprising that the total effect has increased. Such estimates reinforce our confidence in the benchmark results.

We also tested the robustness of our base results to the estimation method by re-estimating the model using Seemingly Unrelated Regression (SUR). By doing so, we are running the model without instrumenting for the endogenous variables. Given the evidence we have found of bi-directional relationships between corruption and growth, the use of SUR should lead to inconsistent estimates. Nonetheless, we present the results in column 3 of Table 7. The signs on all the channels are preserved. Moreover, the total effect continues to be negative, albeit considerably reduced in magnitude and no longer statistically significant. Such results again highlight the importance of accounting for endogeneity in the relationship between corruption and growth.

[Table 7]

The final alteration made to the model is to replace the ICRG corruption index with the World Bank's Control of Corruption (COC) Index. The latter index is available only for the period 1996-2005 and thus forces us to lose two time periods. Consequently, we expect this loss in data will lead to higher standard errors and lower significance of the coefficients. The results from the COC index measure are detailed in fourth, fifth, and sixth columns of Table 7. In most case the signs of the channel effects are maintained. The most notable change is the reverse of the openness channel, which is uniform across all three specifications using the COC measure. This again highlights the low robustness of the openness channel, which frequently changes magnitude, significance, and now in sign. The magnitude of the combined effect increases, with a one-standard deviation change in the COC index (1.101) associated with 0.58 percentage point decrease in growth. However, the precision of this combined effect has fallen. The total effect corruption on growth also increases to approximately 0.6 percentage points. In the main, the results seem relatively robust to this alternative measure, especially given that half of the data is lost when using this measure.

4.2.2 Sample Coverage: Geography, Governance, and Regulation

In this subsection we test the robustness of the benchmark results to the sample under consideration. We split the sample data based upon three factors: geography, governance levels, and degree of regulation. The factors were chosen to address recent empirical results that show no or positive relationships between corruption and growth in economies with low governance levels or a high degree of regulation (Aidt *et al.*, 2008; Méon and Weill, 2008). The results of these changes in sample coverage are reported in Tables 8, 9, and 10. With the loss of countries, the number of degrees of freedom will be reduced, and consequently, larger standard errors and lower significance of the coefficients is expected.

Firstly, we re-estimate the benchmark model for sub-samples of OCED, Latin American, Sub-Saharan African, and East Asian countries. Most channels are robust to the splitting of the sample. Investment is affected most by the exclusion of OECD countries, changing in sign and becoming insignificant. The sign on human capital is preserved in all cases but insignificant when OECD and Latin American countries are excluded. The political instability channel is the most robust over the different restrictions. It maintains its sign and significance in all regions. The sign on government size is preserved but becomes insignificant when Sub-Saharan countries are excluded. The openness channel changes in sign twice over the different regions and is insignificant in all the different specifications, again indicating this channel is the least robust. Overall, the negative total effect of corruption on growth is maintained in all the sub-samples. However, this effect is insignificant when OECD countries are excluded. As OECD countries would generally have high levels of governance, this result seems supportive of Aidt *et al.* (2008) finding that corruption has no impact on growth in economies with low quality instiutions.

[Table 8, 9, and 10]

We look at the issue further by explicitly excluding economies based upon rating of levels of goverance. We ultise two sources of ratings: ICRG ratings on democratic accountability and law and order; and the World Banks's Goverance Matters rating on government effectiveness, rule of law, absence of violence, and voice and accountability.[29] In order to strike an appropriate balance between excluding high governance countries and the loss of degrees of freedom, we use each rating to exclude the countries that are gauged in the top 25 percent of governance quality.[30] The results are reported in Table 9. When excluding the top quartile of sampled countries based upon all but one of the governance measures (absence of violence) the combined effect of corruption on growth remain negative and statistically significant at a 90 percent confidence level. Most notably, the total effect has reduced in absolute magnitude, driven mostly by a reduction in the investment channel. The negative total effect is thus maintained primarily through the political instability channel, which is significant across excluded specifications. Such results are intuitively appealing: corruption may "grease-the-wheel" and allow investments to increase, yet that effect is only partial. The negative influence of corruption on growth via political instability maintains its overall negative influence.

The positive influence of corruption on growth via a "grease-the-wheel" effect may be most pronounced in economies burdened by a high degree of regulation. Consequently, we repeat the country-exclusion exercise based upon measures of regulation. We use each rating to exclude the countries that are gauged in the bottom 25 percent of regulation levels.[31] The results are reported in Table 10. Again the results show a marked decrease in the total effect of corruption on growth. However, the total effect remains negative. The combined effect is statistically significant at a 90 percent confidence level using two of the measures and marginally insignificant using the other two measures to split the sample. Again the significant negative influence of corruption via the political instability channel is maintained. Our results, therefore, appear consistent with the broad theme of Aidt *et al.* (2008): namely, the negative effect of corruption on growth is dampened in economies with low governance levels. However, the idea that corruption could be beneficial in economies with low quality institutions appears unsupported, with the negative effect of corruption on growth via the political instability channel robust even in these economies.

4.3 Extensions and Exhaustiveness of the model

In this final subsection we test whether the benchmark model fully captures the total effect of corruption on economic growth. The omisson of one or more channels could bias the total effect of corruption and/or influence the relative contributions of the various channels. Consquently, two methods are employed to test the exhaustivness of the benckmark model. Frist, we consider an additional channel and examine its impact on the model. Second, we undertake a test involving the residual of the growth equations.

A possible channel omitted from our model is capital inflows. Corruption may undermine a country's ability to attract foreign capital. In a study of the capital flows from fourteen source countries to 45 host countries, Wei (2000)found that a rise in corruption levels in a host country reduces inward foreign direct investment (FDI). Such a result is consistent with the negative correlation (-0.07) between corruption and FDI in our sample period.

Accordingly, we examine whether FDI could constitute another channel linking corruption to growth. The determinants of FDI include the log of intital income, log inflation, terms of trade shocks, distance to major commerical areas, log population, population density and several measures of the social envriornment – ethnolingustic fractionalization, protestant population, index of democracy and war count. We present the results of adding this channel to the benchmark model. We also re-run the systematic specification search as well as several of the sensivity tests we employed eariler. The estimates are displayed in Tables 11 and 12.

[Table 11 and 12]

The results indicate that FDI does not appear to be a significant channel linking corruption to growth. The channel is never statistically different from zero even at a 90 percent level of confidence. In some cases this is due to a weak effect of FDI on growth and in other cases because of a weak effect of corruption on FDI. Most importantly, the inclusion of the FDI channel does not appear to effect the estimates of the other channels. The four robust channels – investment, human capital, political instability, and government size – maintain their formerly estimated signs and significance, while opennness continues to fluctuate in magnitude and statistical signficiance. Thus, the benchmark results do not appear sensitive to the omission of the FDI channel.

A quasi-formal test of exhaustivness is provided by Wacziarg (2001). This simple test involves regressing the residual vector obtained from the system estimates of the growth regression on the corruption index. A correlation between the estimated residual and the corruption index could indicate that a significant channel has been omitted from the growth equation.[32] The results are presented in Table 13. In all the models the null hypothesis that the residual effect is not significantly different from zero cannot be rejected at any reasonable level of significance. This reinforces our confidence that no major channel has been ommitted and that our benchmark model has captured the effect of corruption on economic growth.

[Table 13]

5. Conclusion

This article utilises an econometric methodology that attempts to account for the multi-dimensional nature of, and the inherent endogeneity in, the corruption-growth relationship. This methodology entailed the joint estimation of a system of equations in which the nexus between corruption and growth could be explained by the growth-determining transmission channels which corruption affects. While many past studies have found only a weak statistical relationship between corruption and growth at the macro-level, we find a statistically robust negative total effect. The methodology employed in this study allows us to describe what drives this overall result. Substantial evidence is found that suggests corruption is detrimental to growth through adversely effecting investments in physical capital, human capital levels, and political stability. These effects are somewhat dampened by growth-fostering effects through decreasing government consumption and increasing trade openness. In the main, these effects are found to be robust to changes in specification, sample coverage, and estimation method. The effect through the openness channel, however, is found to be weak and not robust across different specifications and sub-samples. Moreover, our results appear supportive of the notion that the negative effect of corruption on growth is diminished in economies with low governance levels or a high degree of regulation. However, the idea that corruption could be beneficial in economies with low quality institutions appears unsupported, with the negative effect of corruption on growth via the political instability channel robust in even these economies. These results are found to be robust to alternative measures of governance and regulation. Our results suggest that, while policies that reduce the level of corruption are necessary, a "one-size-fits-all" approach is inappropriate. More specifically, it is important to be context-specific and focus on those aspects of corruption that most constrain development (c.f. Rodrik, 2006).

Overall, the results of this paper are consistent with the hypothesis that corruption is, in the main, harmful to economic growth. However, the corruption-growth relationship is not straightforward, and efforts to improve governance and reduce unnecessary regulations are needed in combination with efforts to reduce corruption levels. And all of this should ideally be tailored to the specific nature of the economy under consideration.

Notes

[1] See Bardhan (1997) and Sveenson (2005) for reviews of existing literature.

[2] Kaufmann (1997) offers a survey of the practical and theoretical shortcomings of "efficient corruption" arguments.

[3] Wade (1982) finds such patterns of behaviour in the context of government funded canals in India.

[4] See Lambsdorff (1999) for a review of earlier studies.

[5] However, a robust relationship between human-capital variable and growth has been difficult to establish in some studies (see Bils and Klenow, 2000; Pritchett, 2001).

[6] Admittedly corruption probably has a greater impact on the types of government's activities undertaken rather than the size of government expenditure. For example, Delavallade (2006) shows that corruption distorts the structure of public spending by reducing the portion of social expenditure and increasing the part dedicated to public services and order, fuel and energy, culture, and defense. Since we lack sufficient data to capture these effects we use public consumption as an imperfect proxy.

[7] Southgate *et al.* (2000) observed that tight controls on the circulation and utilization of Ecuadorian forest products opened up multiple opportunities for bribery.

[8] The Solomon Island provides an example of the potential impact corruption can have on political instability. In 2006, only three weeks after being elected Solomon Islands' Prime Minister, Snyder Rini resigned as riots in the capital, Honiara, caused damage to property and businesses and resulted in the deployment of hundreds of foreign troops and police. The prime cause of the riots was allegations against the former prime minister of electoral corruption and favouritism.

[9] The econometric theory underlying this model is an extension of the three-stage least squares method developed by Zellner and Theil (1962) to the case of panel data.

[10] The notation follows directly from Tavares and Wacziarg (2001), whereby the superscripts indicate equations while subscripts indicate variables.

[11] Due to this restriction we can drop the time notation.

[12] Note, however, we report standard errors that are robust to heteroskedasticity (White-robust).

[13] Wacziarg (2001) model also includes feedback via the inclusion of growth in the openness equation (see Table C-1 on page 428 of his paper). Nonetheless, Wacziarg does not include the calculation of this feedback effect in his calculation of the total effect of openness on economic growth. Since growth is the only channel in this model the feedback is minimal. This could perhaps explain the absence of a total effect calculation.
[14] The total effects presented in all the tables take the first round change in corruption to be 1.
[15] This result is a generalisation of Greene (2003: 392) to the case of panel data.
[16] The standard errors on the products of coefficients are calculated by a linear Taylor series expansion around the estimated parameter, and sequentially, calculate the corresponding the standard errors using the formula for the variance of linear function of random variables.
[17] We examine the sensitivity of our method to by reporting Seemingly Unrelated Regression (SUR) estimates. The SUR method does not instrument the endogenous variables but does take advantage of possible cross-equation error correlations to improve the efficiency of the estimates.
[18] See Gallant and Jorgenson (1979)
[19] See Tables A1, A2, and A3 for a complete description of the data; including descriptions, sources, country coverage, and summary statistics.
[20] Note that the use of five-year and six-year periods was purely a consequence of the 22 years.
[21] The index originally varied from 0 to 6, with *higher* values indicating *less* corruption. For easy of interpretation in the regression results we have reversed the values so that higher values of the index imply higher corruption.
[22] See Kaufmann, Kraay & Mastruzzi (2008)
[23] See Figures A1 to A6 in the appendix for graphs of the relationship between the main variables and corruption.
[24] Table A4 in the appendix presents the whole system estimates for the benchmark theoretical model from which the results in Table 3 are taken.
[25] Following Tavares and Wacziarg (2001) we also report a Wald test for the non-linear hypothesis that the sum of the individual channels is insignificantly different from zero.
[26] Interestingly, the impact of corruption is found to be roughly similar to the effect of democracy on growth (0.355) as estimated by Tavares and Wacziarg (2001: 1359).
[27] This is to be expected as the inclusion of the region dummies is equivalent to disregarding some of the between-country variation in the determinants of the channels, which may drive much of the partial co-variation between the right-hand-side variables and corruption (Tavares and Wacziarg, 2001).
[28] See Table A4 in the appendix.
[29] See Table A1 in the appendix for descriptions and sources of the variables.
[30] The World Bank's government effectiveness and rule of law measures both lead to the exclusion of the same countries and thus are reported together.
[31] See Table A1 for a description of the regulation measures.
[32] As Wacziarg (2001: 421) notes, this test should not be taken as an absolute proof that the model is fully exhausted but rather an indication that no major channel has been omitted.

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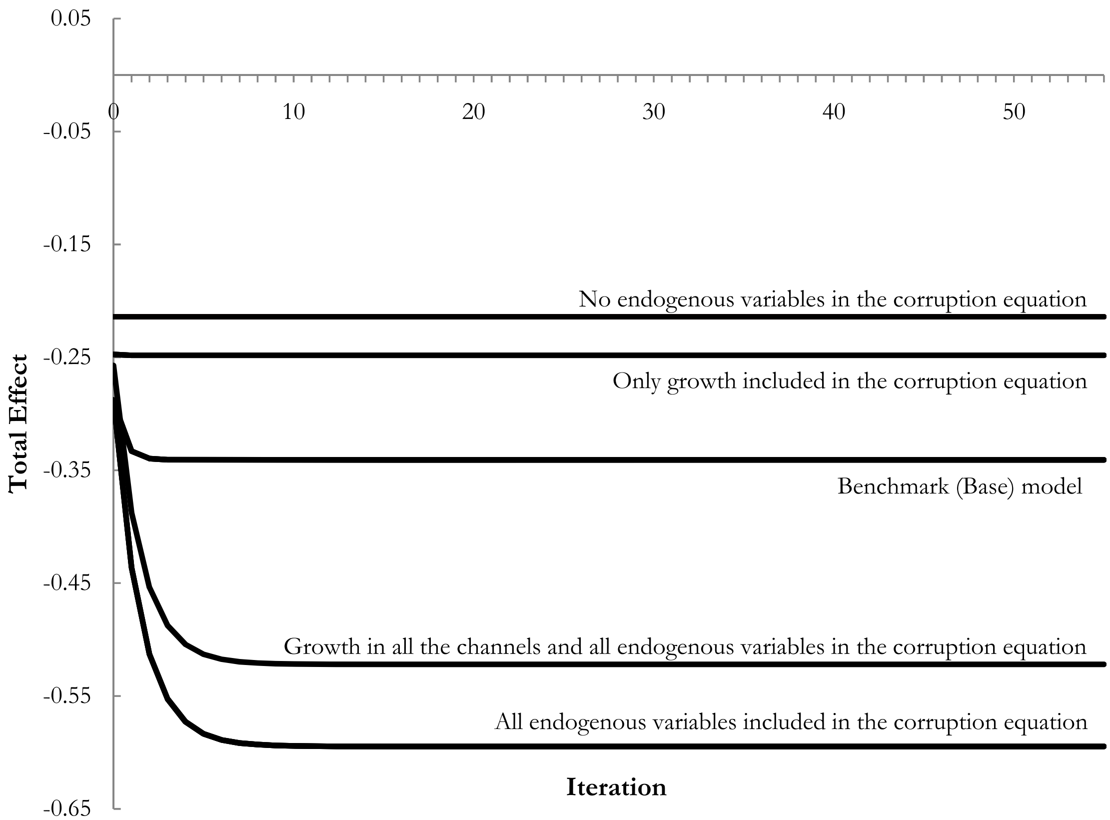
Tables and Figures

Figure 1: Convergence of Total Effects



Notes: See Table 4 for further details.

Table 1: Benchmark model specification

Dependent Variable	Growth	Invest.	Human Capital	Open	Political Instab.	Gov't Size	Corrupt.
Equation Number	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Endogenous Variables							
Growth							γ_1^7
Investment	γ_2^1						
Human Capital	γ_3^1						
Openness	γ_4^1	γ_4^2	γ_4^3			γ_4^6	γ_4^7
Political Instability	γ_5^1					γ_5^6	γ_5^7
Government Size	γ_6^1	γ_6^2	γ_6^3		γ_6^5		
Corruption		γ_7^2	γ_7^3	γ_7^4	γ_7^5	γ_7^6	
Exogenous Variables							
Intercept	δ_1^1	δ_1^2	δ_1^3	δ_1^4	δ_1^5	δ_1^6	δ_1^7
Log initial income	δ_2^1	δ_2^2	δ_2^3	δ_2^4	δ_2^5	δ_2^6	δ_2^7
Population density						δ_3^6	
Log population		δ_4^2	δ_4^3	δ_4^4		δ_4^6	δ_4^7
Age dependency		δ_5^2	δ_5^3			δ_5^6	
War count					δ_6^5		
Postwar independence				δ_7^4	δ_7^5	δ_7^6	
Former British colony			δ_8^3		δ_8^5	δ_8^6	δ_8^7
Oil producing nations				δ_9^4			
Etholinguistic frac.		δ_{10}^2	δ_{10}^3		δ_{10}^5	δ_{10}^6	
Protestant			δ_{11}^3	δ_{11}^4			δ_{11}^7
Eastern Religions		δ_{12}^2	δ_{12}^3				
Democracy index			δ_{13}^3		δ_{13}^5		
Democracy index squared					δ_{14}^5		
Democratic since 1950					δ_{15}^5		δ_{15}^7
Press freedom							δ_{16}^7
Log inflation					δ_{17}^5		
Terms of trade shocks				δ_{18}^4		δ_{18}^6	
Log air distance				δ_{19}^4	δ_{19}^5		δ_{19}^7
Log area				δ_{20}^4			
Landlocked				δ_{21}^4		δ_{20}^6	δ_{21}^7
Island				δ_{22}^4	δ_{22}^5	δ_{22}^6	

Notes: See Table A4 for full estimation of this model. Blanks here indicate zero restrictions are imposed in the model, which are drawn for theory. These exclusion restrictions ensure the identifiability of the model.

Table 2: Correlation matrix for the main variables (1984-2005 average)

	Growth	Corruption	Log Initial Income	Investment	Human Capital	Openness	Political Instability
Corruption	-0.142**	1					
Log Initial Income	0.197***	-0.665***	1				
Investment	0.363***	-0.480***	0.633***	1			
Human Capital	0.232***	-0.654***	0.844***	0.637***	1		
Openness	0.118**	-0.006	0.099*	0.158***	0.119**	1	
Political Instability	-0.154***	0.298***	-0.301***	-0.260***	-0.233***	-0.188***	1
Government Size	-0.020	-0.494***	0.472***	0.282***	0.385***	0.267***	-0.251***

Notes: Number of countries: 81. Variables are described in the relevant text and in Table A1 of the appendix. Asterisks indicate the correlation is significant at the 10% (*), 5% (**), and 1% (***) levels.

Table 3: Simultaneous growth-corruption model: Benchmark specification

Channel	Effect of corruption on the channel	Effect of the channel on growth	Effect of corruption on growth
Investment	-1.3344	0.1958	-0.2612
	(-7.467)	(8.193)	(-5.662)
Human Capital	-0.1922	0.2241	-0.0431
	(-7.067)	(2.934)	(-2.755)
Openness	8.3686	0.0051	0.0429
	(7.162)	(1.889)	(1.766)
Political Instability	0.1060	-1.1781	-0.1249
	(6.123)	(-5.552)	(-4.317)
Government Size	-1.5304	-0.0633	0.0968
	(-8.174)	(-2.178)	(2.190)
Combined Effect			**-0.2894**
			(-3.515)
Wald test			12.353
(*p*-value)			(0.0004)
Total Effect			**-0.3409**
Number of iterations			20
Number of observations			81

Notes: Estimated by 3SLS. The second column presents the coefficient of corruption on the channel equations, the third column presents the coefficients of the channel variables in the growth equation, and the last column presents the product effect (that is, the product of the two coefficients). The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix. The full model is reported in Table A4 of the appendix.

Table 4: Simultaneous growth-corruption model: Feedback Effects

Channel	Base model	No endogenous variables in the corruption equation	Only growth included in the corruption equation	All endogenous variables included in the corruption equation	Growth in all channels and all endogenous variables in the corruption equation
Investment	-0.2612	-0.2528	-0.2655	-0.3093	-0.4507
	(-5.66)	(-5.55)	(-5.71)	(-6.20)	(-9.46)
Human Capital	-0.0431	-0.0410	-0.0423	-0.0537	-0.0113
	(-2.76)	(-2.70)	(-2.77)	(-2.86)	(-0.65)
Openness	0.0429	0.0344	0.0303	0.0581	0.1734
	(1.77)	(2.07)	(1.91)	(2.30)	(5.65)
Political Instability	-0.1249	-0.0582	-0.0639	-0.1094	-0.1022
	(-4.32)	(-2.75)	(-2.83)	(-4.07)	(-4.39)
Government Size	0.0968	0.1036	0.0940	0.1429	0.1337
	(2.19)	(2.33)	(2.15)	(2.45)	(2.50)
Combined Effect	**-0.2894**	**-0.2140**	**-0.2474**	**-0.2713**	**-0.2571**
	(-3.51)	**(-2.84)**	**(-3.28)**	**(-2.82)**	**(-3.01)**
Wald test	12.3527	8.0850	10.7541	7.9245	9.0440
(*p*-value)	(0.0004)	(0.0045)	(0.0010)	(0.0049)	(0.0026)
Total Effect	**-0.3409**	**-0.2140**	**-0.2482**	**-0.5945**	**-0.5219**
Number of iterations	20	NA	8	54	53
Number of observations	81	81	81	81	81

Notes: Estimated by 3SLS. Each column presents the product effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 5: Simultaneous growth-corruption model: Systematic specification search

Channel	Base model	All endogenous Full	All endogenous iteration # 1	All endogenous iteration # 2	All endogenous iteration # 3
Investment	-0.2612	-0.2970	-0.3097	-0.3096	-0.3114
	(-5.66)	(-4.92)	(-5.10)	(-5.16)	(-5.28)
Human Capital	-0.0431	-0.0347	-0.0309	-0.0308	-0.0302
	(-2.76)	(-2.23)	(-2.03)	(-1.97)	(-2.04)
Openness	0.0429	0.0954	0.0977	0.0977	0.0953
	(1.77)	(2.44)	(2.41)	(2.42)	(2.37)
Political Instability	-0.1249	-0.1006	-0.0981	-0.0995	-0.0982
	(-4.32)	(-3.61)	(-3.49)	(-3.53)	(-3.51)
Government Size	0.0968	0.1357	0.1267	0.1272	0.1171
	(2.19)	(2.22)	(2.04)	(2.05)	(1.88)
Combined Effect	**-0.2894**	**-0.2012**	**-0.2143**	**-0.2150**	**-0.2274**
	(-3.51)	**(-1.83)**	**(-1.92)**	**(-1.93)**	**(-2.07)**
Wald test	12.3527	3.3671	3.6885	3.7416	4.2694
(*p*-value)	(0.0004)	(0.0665)	(0.0548)	(0.0531)	(0.0388)
Total Effect	**-0.3409**	**-0.6595**	**-0.6867**	**-0.6926**	**-0.7185**
Number of iterations	20	97	94	95	93
Number of observations	81	81	81	81	81
QLR Statistic (total)			60.2554	66.8208	75.3842
(*p*-value)			(0.291)	(0.226)	(0.118)

Notes: Estimated by 3SLS. Each column presents the product effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 6: Simultaneous growth-corruption model: Sensitivity to specification

Channel	Base model	Time specific intercepts	Time and geographical regions in channel equations	Time and geographical regions in channel and corruption equations	Time and geographical regions in all equations	Exclude initial income	Growth in all channels
Investment	-0.2612	-0.2665	-0.1027	-0.1058	-0.0820	-0.4123	-0.3431
	(-5.66)	(-5.05)	(-2.43)	(-2.42)	(-2.24)	(-6.90)	(-7.27)
Human Capital	-0.0431	-0.0439	-0.0363	-0.0394	-0.0447	-0.1053	-0.0079
	(-2.76)	(-2.08)	(-1.80)	(-1.93)	(-1.97)	(-4.08)	(-0.54)
Openness	0.0429	0.0113	0.0122	0.0141	0.0039	0.0260	0.1597
	(1.77)	(1.23)	(1.07)	(1.12)	(0.34)	(1.47)	(5.30)
Political Instability	-0.1249	-0.1892	-0.1224	-0.1008	-0.1578	-0.1228	-0.1172
	(-4.32)	(-4.37)	(-3.32)	(-2.97)	(-3.43)	(-3.93)	(-4.71)
Government Size	0.0968	0.0907	0.0715	0.0656	-0.0026	0.0995	0.0957
	(2.19)	(1.83)	(1.46)	(1.36)	(-0.05)	(1.30)	(2.25)
Combined Effect	**-0.2894**	**-0.3975**	**-0.1777**	**-0.1663**	**-0.2832**	**-0.5149**	**-0.2127**
	(-3.51)	**(-4.67)**	**(-2.12)**	**(-1.99)**	**(-3.30)**	**(-4.73)**	**(-2.76)**
Wald test	12.3527	21.7861	4.4836	3.9585	10.8755	22.3749	7.5902
(*p*-value)	(0.0004)	(0.0000)	(0.0342)	(0.0466)	(0.0010)	(0.0000)	(0.0059)
Total Effect	**-0.3409**	**-0.4647**	**-0.1952**	**-0.1787**	**-0.3058**	**-0.5877**	**-0.2522**
Number of iterations	20	19	16	14	15	18	20
Number of observations	81	81	81	81	81	81	81

Notes: Estimated by 3SLS. Each column presents the product effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 7: Simultaneous growth-corruption model: Sensitivity to alterations

Channel	Base model (1984-2005)	SUR estimates	COC Measure (1996-2005)	COC Measure Time and geographical regions in channel and corruption equations (1996-2005)	COC Measure Time and geographical regions in all equations (1996-2005)
Investment	-0.2612	-0.1238	-0.4652	-0.0036	-0.0207
	(-5.66)	(-4.36)	(-2.74)	(-0.03)	(-0.14)
Human Capital	-0.0431	-0.0154	-0.0795	-0.3081	-0.3784
	(-2.76)	(-2.04)	(-1.00)	(-2.11)	(-2.43)
Openness	0.0429	0.0163	-0.2013	-0.1223	-0.0937
	(1.77)	(1.13)	(-1.85)	(-1.56)	(-1.28)
Political Instability	-0.1249	-0.0387	0.0583	-0.1218	-0.2015
	(-4.32)	(-2.45)	(0.64)	(-0.97)	(-1.24)
Government Size	0.0968	0.0950	0.1607	0.0495	0.0419
	(2.19)	(2.73)	(1.28)	(0.43)	(0.29)
Combined Effect	**-0.2894**	**-0.0666**	**-0.5269**	**-0.5063**	**-0.6524**
	(-3.51)	**(-1.15)**	**(-2.21)**	**(-1.96)**	**(-2.09)**
Wald test	12.3527	1.3120	4.8912	3.8463	4.3613
(*p*-value)	(0.0004)	(0.2520)	(0.0270)	(0.0499)	(0.0368)
Total Effect	**-0.3409**	**-0.0700**	**-0.5437**	**-0.5200**	**-0.6814**
Number of iterations	20	13	11	11	12
Number of observations	81	81	81	81	81

Notes: Estimated by 3SLS, unless otherwise stated. Each product presents the combined effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 8: Simultaneous growth-corruption model: Sensitivity to geographic coverage

Channel	Base model	Exclude the OECD	Exclude Latin America	Exclude Sub-Saharan Africa	Exclude East Asia
Investment	-0.2612	0.0065	-0.1487	-0.2439	-0.1360
	(-5.66)	(0.23)	(-4.68)	(-5.22)	(-3.67)
Human Capital	-0.0431	-0.0090	-0.0121	-0.0648	-0.0230
	(-2.76)	(-0.76)	(-1.14)	(-3.31)	(-2.70)
Openness	0.0429	-0.00003	-0.0004	0.0240	0.0185
	(1.77)	(-0.003)	(-0.04)	(1.28)	(0.63)
Political Instability	-0.1249	-0.0586	-0.0360	-0.0386	-0.1152
	(-4.32)	(-2.62)	(-1.92)	(-2.14)	(-3.36)
Government Size	0.0968	0.0397	0.0493	0.0178	0.1036
	(2.19)	(1.96)	(2.18)	(0.48)	(2.97)
Combined Effect	**-0.2894**	**-0.0214**	**-0.1478**	**-0.3056**	**-0.1522**
	(-3.51)	**(-0.45)**	**(-3.03)**	**(-4.17)**	**(-1.74)**
Wald test	12.3527	0.2050	9.1725	17.4056	3.0436
(*p*-value)	(0.0004)	(0.6508)	(0.0025)	(0.0000)	(0.0811)
Total Effect	**-0.3409**	**-0.0223**	**-0.1555**	**-0.3293**	**-0.1866**
Number of iterations	20	12	13	15	22
Number of observations	81	59	59	63	76

Notes: Estimated by 3SLS. Each product presents the combined effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 9: Simultaneous growth-corruption model: Sensitivity to governance levels

Channel	Base model	DA Measure	LO Measure	COCG & COCL Measures	COCP Measure	COCV Measure
Investment	-0.2612	-0.0365	-0.0376	-0.0665	-0.0603	-0.0390
	(-5.66)	(-1.16)	(-1.19)	(-2.18)	(-2.01)	(-1.42)
Human Capital	-0.0431	-0.0071	0.0011	-0.0071	-0.0344	-0.0361
	(-2.76)	(-0.52)	(0.09)	(-0.61)	(-2.85)	(-2.57)
Openness	0.0429	0.0012	-0.0071	0.0010	0.0082	0.0066
	(1.77)	(0.38)	(-0.64)	(0.39)	(0.45)	(0.58)
Political Instability	-0.1249	-0.1135	-0.0905	-0.0789	-0.0882	-0.0860
	(-4.32)	(-3.43)	(-3.16)	(-2.92)	(-3.14)	(-3.10)
Government Size	0.0968	0.0452	0.0400	0.0405	0.1030	0.0418
	(2.19)	(1.74)	(1.93)	(1.76)	(3.34)	(1.77)
Combined Effect	**-0.2894**	**-0.1106**	**-0.0941**	**-0.1110**	**-0.0716**	**-0.1127**
	(-3.51)	**(-1.92)**	**(-1.75)**	**(-2.23)**	**(-1.17)**	**(-2.07)**
Wald test	12.3527	3.6692	3.0616	4.9507	1.3631	4.2810
(*p*-value)	(0.0004)	(0.0554)	(0.0802)	(0.0261)	(0.2430)	(0.0385)
Total Effect	**-0.3409**	**-0.1179**	**-0.1013**	**-0.1173**	**-0.0791**	**-0.1203**
Number of iterations	20	14	15	13	16	14
Number of observations	81	61	61	61	61	61

Notes: Estimated by 3SLS. Countries rated in top quartile are excluded. Each column presents the product effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 10: Simultaneous growth-corruption model: Sensitivity to regulation levels

Channel	Base model	IP Measure	BQ Measure	EFW Reg Measure	COC Reg Measure
Investment	-0.2612	-0.0455	-0.0810	-0.1306	-0.0304
	(-5.66)	(-1.61)	(-2.42)	(-3.67)	(-1.12)
Human Capital	-0.0431	-0.0422	0.0145	0.0067	-0.0077
	(-2.76)	(-3.06)	(1.80)	(0.85)	(-0.73)
Openness	0.0429	0.0067	0.0033	-0.0466	0.0061
	(1.77)	(0.38)	(0.63)	(-2.29)	(0.58)
Political Instability	-0.1249	-0.0810	-0.0934	-0.0497	-0.0901
	(-4.32)	(-3.02)	(-2.99)	(-2.83)	(-3.40)
Government Size	0.0968	0.0845	0.0498	0.1251	0.0451
	(2.19)	(3.25)	(1.78)	(6.60)	(1.79)
Combined Effect	**-0.2894**	**-0.0775**	**-0.1068**	**-0.0951**	**-0.0771**
	(-3.51)	**(-1.45)**	**(-1.85)**	**(-1.72)**	**(-1.53)**
Wald test	12.3527	2.0937	3.4267	2.9682	2.3523
(*p*-value)	(0.0004)	(0.1479)	(0.0642)	(0.0849)	(0.1251)
Total Effect	**-0.3409**	**-0.0852**	**-0.1127**	**-0.1042**	**-0.0824**
Number of iterations	20	16	13	16	14
Number of observations	81	61	61	61	61

Notes: Estimated by 3SLS. Countries rated in top quartile are excluded. Each column presents the product effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 11: Simultaneous growth-corruption model: Sensitivity to extension, FDI channel

Channel	Base model	Base model with FDI channel	Base model with FDI channel Full	Base model with FDI channel iteration #1	Base model with FDI channel iteration #2	Base model with FDI channel iteration #3	Base model with FDI channel iteration #4
Investment	-0.2612	-0.2685	-0.2822	-0.2975	-0.2921	-0.3066	-0.3082
	(-5.66)	(-6.20)	(-4.84)	(-5.45)	(-5.36)	(-5.51)	(-5.55)
Human Capital	-0.0431	-0.0396	-0.0411	-0.0409	-0.0418	-0.0412	-0.0422
	(-2.76)	(-2.79)	(-2.38)	(-2.33)	(-2.35)	(-2.26)	(-2.29)
Openness	0.0429	0.0217	0.0370	0.0163	0.0173	0.0201	0.0203
	(1.77)	(0.94)	(1.29)	(0.65)	(0.70)	(0.82)	(0.82)
Political Instability	-0.1249	-0.1229	-0.1171	-0.1203	-0.1199	-0.1200	-0.1212
	(-4.32)	(-4.56)	(-4.10)	(-4.40)	(-4.28)	(-4.23)	(-4.29)
Government Size	0.0968	0.0897	0.1670	0.1701	0.1728	0.1813	0.1838
	(2.19)	(2.30)	(2.50)	(2.64)	(2.70)	(2.86)	(2.95)
FDI		0.0284	0.0421	0.0407	0.0385	0.0349	0.0317
		(1.08)	(0.74)	(0.78)	(0.72)	(0.65)	(0.59)
Combined Effect	**-0.2894**	**-0.2911**	**-0.1944**	**-0.2316**	**-0.2251**	**-0.2316**	**-0.2359**
	(-3.51)	**(-3.85)**	**(-1.73)**	**(-2.15)**	**(-2.09)**	**(-2.13)**	**(-2.19)**
Wald test	12.3527	14.8500	2.9878	4.6069	4.3737	4.5386	4.7770
(*p*-value)	(0.0004)	(0.0001)	(0.0839)	(0.0318)	(0.0365)	(0.0331)	(0.0288)
Total Effect	**-0.3409**	**-0.3381**	**-0.6541**	**-0.7100**	**-0.6996**	**-0.6972**	**-0.7154**
Number of iterations	20	19	100	89	91	87	88
Number of observations	81	81	81	81	81	81	81

Notes: Estimated by 3SLS. Each column presents the product effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 12: Simultaneous growth-corruption model: Sensitivity to extension, FDI channel, sensitivity to alterations

Channel	Base model	Base model with FDI channel	Time specific intercepts	Time and geographical regions in channel equations	Time and geographical regions in channel and corruption equations	Time and geographical regions in all equations	All endogenous variables in corruption equation	SUR estimates
Investment	-0.2612	-0.2685	-0.2590	-0.1089	-0.1133	-0.0811	-0.3261	-0.1253
	(-5.66)	(-6.20)	(-5.22)	(-2.67)	(-2.70)	(-2.43)	(-6.81)	(-4.88)
Human Capital	-0.0431	-0.0396	-0.0376	-0.0285	-0.0345	-0.0348	-0.0489	-0.0140
	(-2.76)	(-2.79)	(-1.98)	(-1.53)	(-1.81)	(-1.66)	(-2.93)	(-2.08)
Openness	0.0429	0.0217	0.0076	0.0099	0.0117	-0.0055	0.0416	-0.0014
	(1.77)	(0.94)	(0.93)	(0.83)	(0.88)	(-0.49)	(1.73)	(-0.10)
Political Instability	-0.1249	-0.1229	-0.1913	-0.1070	-0.0881	-0.1358	-0.1110	-0.0377
	(-4.32)	(-4.56)	(-4.92)	(-3.47)	(-3.04)	(-3.52)	(-4.24)	(-2.55)
Government Size	0.0968	0.0897	0.0849	0.0869	0.0799	0.0315	0.1475	0.0840
	(2.19)	(2.30)	(2.01)	(1.98)	(1.83)	(0.68)	(2.83)	(2.63)
FDI		0.0284	0.0022	-0.0024	-0.0033	-0.0153	0.0155	0.0370
		(1.08)	(0.37)	(-0.44)	(-0.50)	(-0.97)	(0.62)	(1.72)
Combined Effect	**-0.2894**	**-0.2911**	**-0.3933**	**-0.1501**	**-0.1476**	**-0.2410**	**-0.2815**	**-0.0574**
	(-3.51)	**(-3.85)**	**(-5.07)**	**(-1.97)**	**(-1.91)**	**(-3.07)**	**(-3.12)**	**(-1.02)**
Wald test	12.3527	14.8500	25.6603	3.8738	3.6469	9.4361	9.7414	1.0372
(*p*-value)	(0.0004)	(0.0001)	(0.0000)	(0.0490)	(0.0562)	(0.0021)	(0.0018)	(0.3085)
Total Effect	**-0.3409**	**-0.3381**	**-0.4571**	**-0.1638**	**-0.1575**	**-0.2582**	**-0.5491**	**-0.0602**
Number of iterations	20	19	19	15	14	14	50	13
Number of observations	81	81	81	81	81	81	81	81

Notes: Estimated by 3SLS, unless otherwise stated. Each column presents the product effects under the different specifications. The sum of these products is the combined effect. The total effect is calculated using an iteration process with a convergence criterion that the feedback into the corruption equation be greater than $1 * 10^{-15}$. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Table 13: Testing Exhaustiveness, regressing residuals from the growth regression on corruption

	Base	Base estimated by SUR	Geographical regions included	Exclude OECD	Exclude Latin America	Exclude Sub-Saharan Africa	Exclude East Asia
Intercept	-0.169	0.157	0.881	0.170	0.049	-0.112	0.092
	(-0.51)	(0.49)	(1.30)	(0.24)	(0.14)	(-0.43)	(0.29)
Corruption	**-0.035**	**-0.071**	**-0.075**	**-0.177**	**-0.032**	**0.038**	**-0.117**
	(-0.26)	**(-0.56)**	**(-0.45)**	**(-0.79)**	**(-0.20)**	**(0.35)**	**(-0.94)**
R^2	0.037 0.003	0.047 0.001	0.034 0.091	0.019 0.017	0.042 0.0001	0.073 0.037	0.058 0.001
	0.031 0.046	0.051 0.037	0.028 0.073	0.049 0.001	0.065 0.044	0.041 0.080	0.051 0.020
Number of observations	81	81	81	59	59	63	76

Notes: Estimated by SUR. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix.

Appendix

Figure A1: Growth and Corruption, 1984-2005

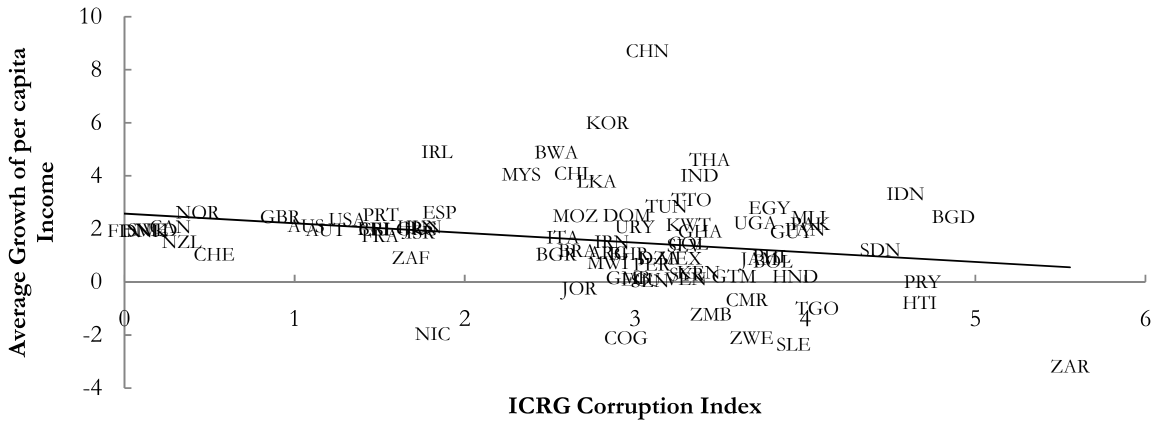


Figure A2: Investment and Corruption, 1984-2005

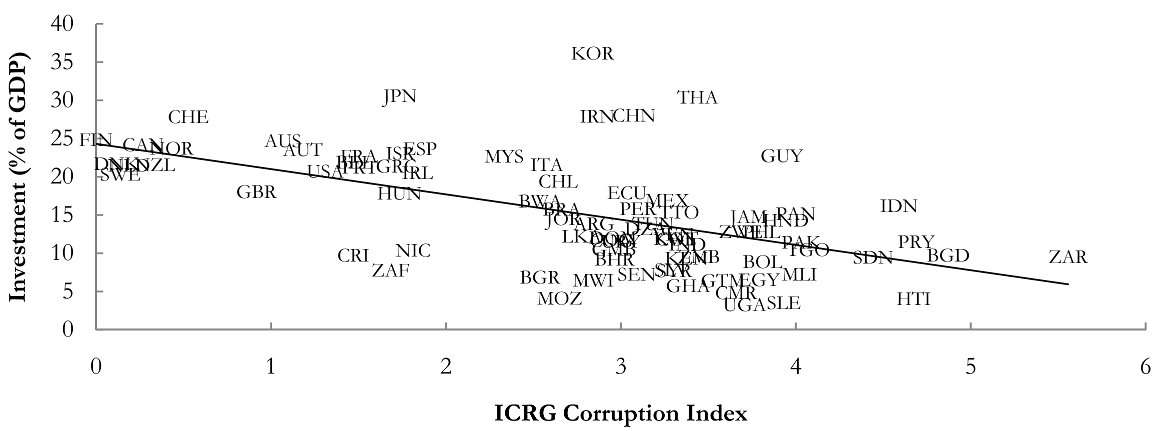


Figure A3: Human Capital and Corruption, 1984-2005

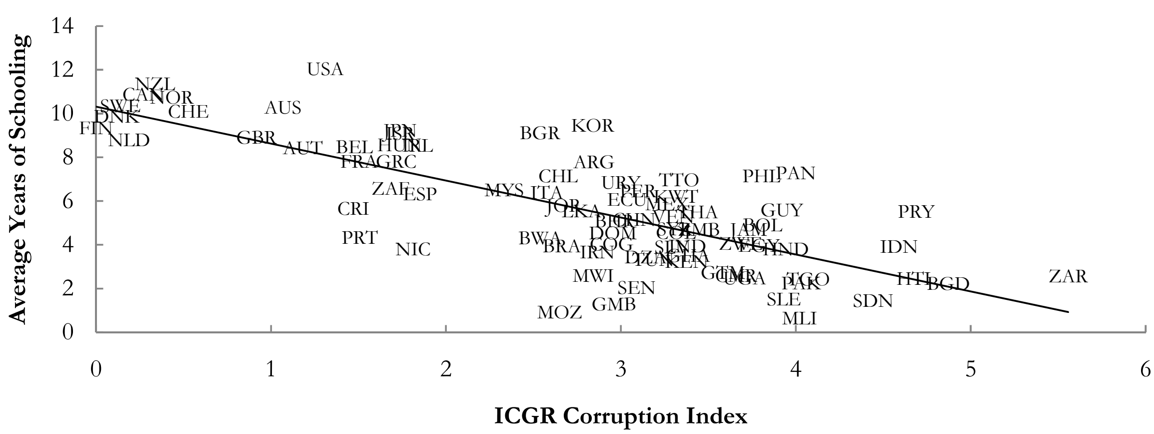


Figure A4: Openness and Corruption, 1984-2005

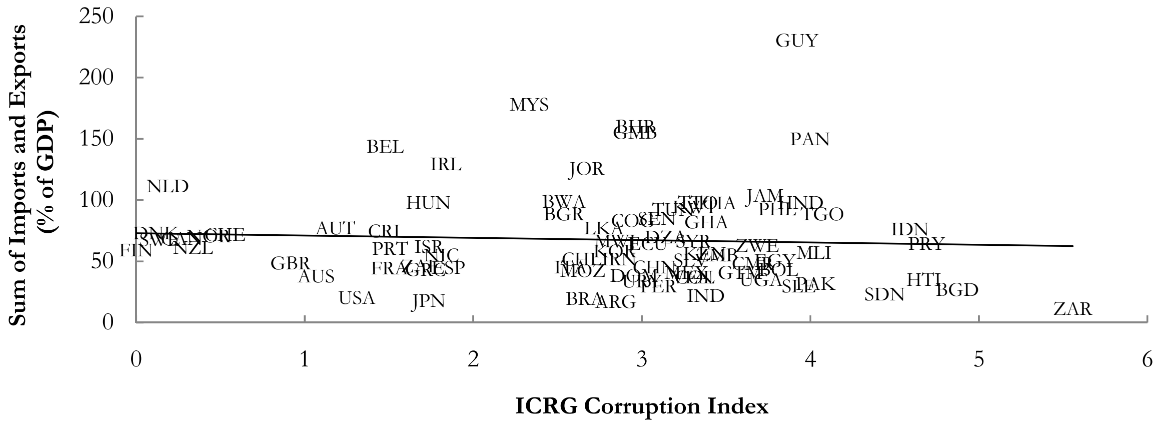


Figure A5: Political Instability and Corruption, 1984-2005

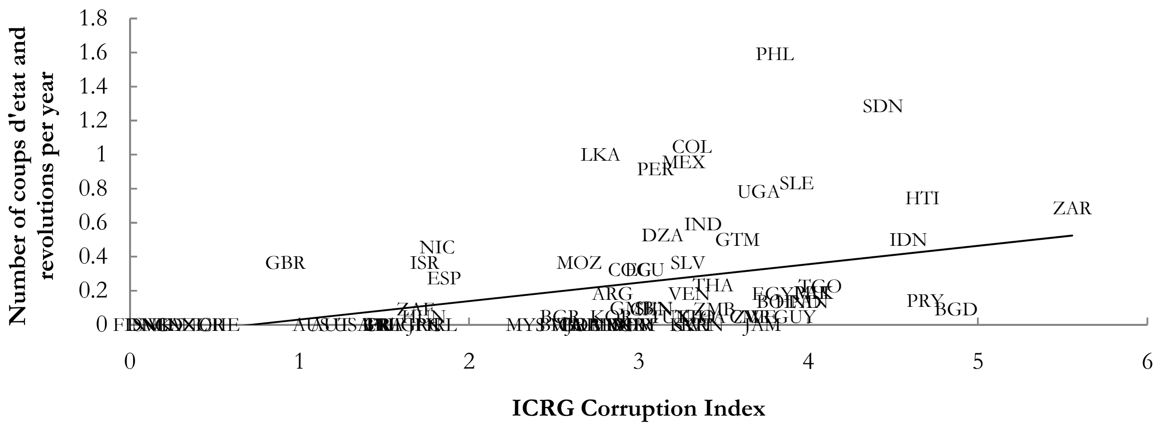


Figure A6: Government Size and Corruption, 1984-2005

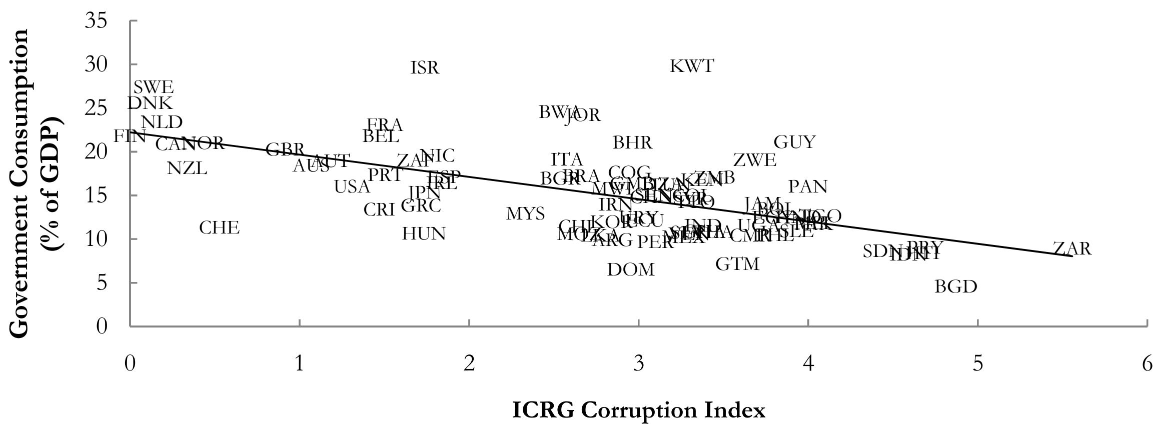


Table A1: Data definitions of variables

Variable	Description
Growth	Growth rate of Purchasing Power Parity (PPP) adjusted Real Gross Domestic Product per capita. *Units*: percent points. *Source*: Heston, Summers, and Aten (2006) and WDI (2008)
Corruption	Index (0-6) of corruption. Based on the analysis of worldwide network of experts. *Units*: 0 = Low Corruption and 6 = High Corruption. *Source*: ICRG (2006)
Control of corruption	Measures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. *Units*: High numbers signify greater corruption. *Source*: Kaufmann *et al.* (2008)
Initial income	Gross Domestic Product per capita based on purchasing power parity (PPP), Chain Index. Measured at the beginning of each period, with missing values calculated from WDI growth rates. *Units*: natural log of per capita GDP (in 000's) in 2000 international dollars. *Source*: Heston, Summers, and Aten (2006) and WDI (2008)
Investment	Rate of physical capital investment in constant prices, with missing values calculated using WDI growth rates of Gross Capital Formation. *Units*: percentage of GDP. *Source*: Heston, Summers, and Aten (2006) and WDI (2008)
Human Capital	Average schooling years in the population over age 25. *Units*: Years. *Source*: Barro and Lee (2000)
Openness	Sum of exports and imports of goods and services, with missing values calculated using WDI growth rates of sum of exports and imports of goods and services. *Units*: percentage of GDP. *Source*: Heston, Summers, and Aten (2006) and WDI (2008)
Political Instability	The number of coups d'état and revolutions per year. Coups are measured as the number of extra constitutional or forced changes in the top government elite and/or its effective control of the nation's power structure in a given year. Unsuccessful coups are not counted. The number of revolutions per year is defined as any illegal or forced change in the top governmental elite, any attempt at such a change, or any successful or unsuccessful armed rebellion whose aim is independence from the central government. *Units*: scalar. *Source*: Banks (2006)
Government Size	General government final consumption expenditure includes all government current expenditures for purchases of goods and services. *Units*: percentage of GDP. *Source*: WDI (2008)
Foreign Direct Investment	Net inflows of foreign investment. *Units*: percentage of GDP. *Source*: WDI (2008)
Population density	Population density. *Units*: people per square kilometer. *Source*: WDI (2008)
Population	Includes all residents regardless of legal status or citizenship - except for refugees not permanently settled in the country of asylum - who are generally considered part of the population of their country of origin. *Units*: natural log of figures scaled in 1,000,000s. *Source*: WDI (2008)
Age dependency	Age dependency ratio is the ratio of dependents – people younger than 15 or older than 64 – to the working-age population – those ages 15-64. *Units*: scalar, e.g. 0.7 means there are 7 dependents for every 10 working-age people. *Source*: WDI (2008)
War count	Number of armed conflicts, external and internal, in which the government was involved as classified by Uppsala Conflict Data Program. *Units*: scalar. *Source*: Teorell, Holmberg & Rothstein (2008)
Postwar independence	Takes a value of 1 if country gained independence after World War II, 0 otherwise. *Units*: dummy variable. *Source*: Gerring *et al.* (2005)
Former British colony	Takes a value of 1 if a former British colony since 1776, 0 otherwise. *Units*: dummy variable. *Source*: Barro (1999)
Oil producing nations	Takes a value of 1 if oil producing country, 0 otherwise. *Units*: dummy variable. *Source*: Barro (1999)
Ethnolinguistic Fractionalization	Probability that two randomly selected persons from a given country will not belong to the same ethnolingustic group. *Units*: probability. *Source*: Alesina *et al.* (2003)
Protestant	Identifies the percentage of the population of each country that belonged to a Protestant denomination in 2000. *Units*: Percent points. *Source*: Barro and McCleary (2002)
Eastern Religions	Identifies the percentage of the population of each country that belonged to an Eastern Religion not including Hinduism in 2000. *Units*: Percent points. *Source*: Barro and McCleary (2002)
Democracy Index	Equally weighted index (1-7) of civil liberties and political rights. Units: 1 = Low Level 7 =

	High Level. *Source*: Freedom House (2008)
Democratic since 1950	Takes a value of 1 if country has experienced uninterrupted democracy for 55 years as classified by Beck et al. (2001), 0 otherwise. *Units:* dummy variable. *Source*: Treisman (2007)
Press freedom	Index (0-100) of free press. *Units*: 0 = Low degree 100 = High degree. *Source*: Freedom House (2008)
Inflation	Percentage change in the cost of the average consumer of acquiring a fixed basket of goods and services, measured by GDP implicit deflator. *Units*: natural log of inflation plus 100. *Source*: WDI (2008)
Terms of trade shocks	Growth rate of export price index multiplied by share of exports in GDP, less the growth rate of import price index multiplied by share of imports in GDP. *Units*: Percent points. *Source*: WDI (2008)
Air distance	The minimum distance to one of the three capital-goods-supplying regions: the U.S., Western Europe, and Japan, specifically measured as distance from the country's capital city to New York, Rotterdam, or Tokyo. *Units*: natural log of the Great-Circle (air) distance in kilometers. *Source*: Sachs and Warner (1995)
Area	Land Area: *Units*: natural log of km^2. *Source*: Sachs and Warner (1995)
Landlocked	Takes a value of 1 if country is landlocked, 0 otherwise. *Units*: dummy variable. *Source*: GDN (2008)
Island	Takes the value of 1 if the country is a geographical island, 0 otherwise. *Units*: dummy variable. *Source*: Aubert and Chen (2008)
Governance Measures	
Democratic Accountability	Index (0-6) of how responsive government is to its people. *Units*: 0 = Mildly Responsive 6 = Highly Responsive (DA Measure). *Source*: ICRG (2006)
Law and Order	Index (0-6) of level of law and order based on strength and impartiality of judicial system and crime rates. *Units*: 0 = Low level 6 = High level (LO Measure). *Source*: ICRG (2006)
Government Effectiveness	Measures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. (COCG Measure). *Source*: Kaufmann *et al.* (2008)
Rule of Law	Measures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. (COCL Measure). *Source*: Kaufmann *et al.* (2008)
Absence of Violence	Measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. (COCP Measure). *Source*: Kaufmann *et al.* (2008)
Voice and Accountability	Measures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. (COCV Measure). *Source*: Kaufmann *et al.* (2008)
Regulation Measures	
Bureaucracy Quality	Index (0-6) of institutional strength and quality of bureaucracy. *Units*: 0 = Low Quality 4 = High Quality (BQ Measure). *Source*: ICRG (2006)
Investment Profile	Index (0-12) of risk of investment, subcomponents include: contract viability/expropriation, profit repatriation and payment delays. *Units*: 0 = Low Risk and 12 = High Risk (IP Measure). *Source*: ICRG (2006)
EFW Regulation	Index (1-10) of the degree of economic freedom in terms of regulation in the business, credit and labour markets. *Units* 1 = high freedom 10 = low freedom (EFW Reg Measure). *Source*: Gwartney, Lawson and Norton (2008)
Regulatory Quality	Measures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. *Units*: high numbers signify greater regulatory barriers (COC Reg Measure). *Source*: Kaufmann *et al.* (2008)

Table A2: Country coverage

OECD	Latin America and the Caribbean	Middle East and Africa	Asia
Australia [1,2,3,4,5,b,c,d]	Argentina	Algeria	Bangladesh
Austria [1,2,3,4,5,a,b,d]	Bolivia	Bahrain [2,c]	*China*
Belgium [1,2,3,4,5,a,b,d]	Brazil	**Botswana [4,a,c]**	India
Canada [1,2,3,4,5,a,b,c,d]	Chile [3,4,c,d]	Bulgaria	*Indonesia*
Denmark [1,2,3,4,5,a,b,c,d]	Colombia	**Cameroon**	*Malaysia* [c]
Finland [1,2,3,4,5,a,b,c,d]	Costa Rica [4,5]	**Congo**	Pakistan
France [1,2,3,4,5,a,b,d]	Dominican Republic	**Congo, DR**	*Philippines*
Greece	Ecuador	Egypt	Sri Lanka
Hungary [1,2,4,5,b,d]	Guatemala	**Gambia**	*Thailand*
Ireland [1,2,3,4,5,a,b,c,d]	Guyana	**Ghana**	
Italy [2,5,a]	Honduras	Iran	
Japan [1,2,3,4,a,b,c]	Haiti	Israel [1,3,b,d]	
Netherlands [1,2,3,4,5,a,b,c,d]	Jamaica	Jordan	
New Zealand [1,2,3,4,5,a,b,c,d]	Mexico	**Kenya**	
Norway [1,2,3,4,5,a,b,c,d]	Nicaragua	Kuwait [c]	
Portugal [1,2,3,4,5,a,d]	Panama	**Malawi**	
South Korea [a]	Peru	**Mali**	
Spain [1,3,5,a,b,d]	Paraguay	**Mozambique**	
Sweden [1,2,3,4,5,a,b,c,d]	El Salvador	**Senegal**	
Switzerland [1,2,3,4,5,a,b,c,d]	Trinidad & Tobago [c]	**Sierra Leone**	
United Kingdom [1,2,3,4,5,a,b,c,d]	Uruguay	**South Africa [b,c]**	
United States [1,2,3,5,a,b,c,d]	Venezuela	**Sudan**	
		Syria	
		Togo	
		Tunisia	
		Uganda	
		Zambia	
		Zimbabwe	

Notes: Countries in **bold** are sub-Saharan African countries. Countries in *italics* are East Asian countries.

[1] High Governance countries excluded using the DA Measure

[2] High Governance countries excluded using the LO Measure

[3] High Governance countries excluded using the COCG and COCL Measures

[4] High Governance countries excluded using the COCP Measure

[5] High Governance countries excluded using the COCV Measure

[a] Low Regulation countries excluded using the IP Measure

[b] High Bureaucratic quality countries excluded using the BQ Measure

[c] Low Regulation countries excluded using the EFW Reg Measure

[d] Low Regulation countries excluded using the COC Reg Measure

Table A3: Summary statistics (1984-2005 averages)

	Mean	Median	Std. Dev	Minimum	Maximum
Growth	1.542	1.610	2.760	-8.953	11.589
Corruption	2.722	3.000	1.382	0.000	6.000
Control of corruption	-0.164	0.270	1.101	-2.416	1.907
Log initial income	1.671	1.702	1.087	-1.024	3.537
Investment	15.256	13.659	7.692	2.666	39.998
Human Capital	5.691	5.334	2.832	0.489	12.247
Openness	66.974	57.092	42.405	9.890	264.335
Political Instability	0.218	0.000	0.420	0.000	2.500
Government Size	15.263	14.120	5.903	4.055	46.357
Foreign Direct Investment	2.145	1.360	2.727	-5.653	27.384
Population density	116.145	58.900	160.519	2.086	1124.292
Population	2.640	2.377	1.469	-0.846	7.158
Age dependency	0.689	0.664	0.185	0.358	1.108
War count	0.370	0.000	0.776	0	6.833
Postwar independence	0.420	0.000	0.494	0	1
Former British colony	0.358	0.000	0.480	0	1
Oil producing nations	0.074	0.000	0.262	0	1
Ethnolinguistic Frac.	0.437	0.484	0.265	0.002	0.930
Protestant	13.614	4.900	19.807	0	89.700
Eastern Religions	4.878	0.300	16.276	0	86.800
Democracy Index	4.742	5.000	1.855	1	7
Democratic since 1950	0.207	0.000	0.387	0	1
Press freedom	58.246	61.333	23.993	6.667	93.667
Inflation	4.780	4.679	0.355	4.531	7.200
Terms of trade shocks	0.067	-0.248	5.821	-14.149	83.542
Air distance	7.968	8.189	1.026	4.942	9.136
Area	12.451	12.531	1.795	6.500	16.048
Landlocked	0.148	0.000	0.356	0	1
Island	0.148	0.000	0.356	0	1

Notes: Number of countries: 81

Table A4: System estimates for the benchmark specification

	Growth	Investment	Human Capital	Openness	Political Instability	Government Size	Corruption
Intercept	0.1656	8.3720	3.1911	159.6340	-0.4782	6.5137	1.6271
	(0.337)	(3.143)	(5.638)	(6.409)	(-1.982)	(2.244)	(2.448)
Log initial income	-0.9934	2.5785	1.5270	4.9200	-0.0673	3.1662	-0.3823
	(-4.353)	(4.921)	(13.452)	(1.570)	(-2.150)	(5.761)	(-5.845)
Corruption		-1.3344	-0.1922	8.3686	0.1060	-1.5304	
		(-7.467)	(-7.067)	(7.162)	(6.123)	(-8.174)	
Growth							-0.0234
							(-3.470)
Investment	0.1958						
	(8.193)						
Human Capital	0.2241						
	(2.934)						
Openness	0.0051	0.0494	0.0040			0.0160	0.0087
	(1.889)	(9.538)	(3.990)			(2.625)	(9.837)
Political Instability	-1.1781					1.9336	0.6743
	(-5.552)					(6.843)	(10.655)
Government Size	-0.0633	0.0168	-0.0475		0.0065		
	(-2.178)	(0.442)	(-10.746)		(2.169)		
Population density						-0.0024	
						(-1.342)	
Log population		1.8602	0.2370	-11.1866		-0.5283	0.1458
		(6.924)	(2.868)	(-6.211)		(-2.301)	(3.675)
Age dependency		-1.4274	-1.7008			10.6843	
		(-0.600)	(-4.124)			(4.102)	
War count					0.1308		
					(4.012)		
Postwar independence				20.6536	-0.0551	2.2017	
				(3.931)	(-0.853)	(2.415)	
Former British colony			0.8796		-0.0920	2.0170	-0.0571
			(3.780)		(-1.375)	(2.832)	(-0.513)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Oil producing nations				14.1142			
				(2.319)			
Etholinguistic fractionalization		-4.5242	-0.2183		0.0046	-1.8867	
		(-2.931)	(-0.460)		(0.053)	(-1.188)	
Protestant			0.0251	-0.0395			-0.0163
			(4.283)	(-0.480)			(-7.807)
Eastern Religions		0.0913	0.0129				
		(3.520)	(2.394)				
Democracy index			0.1428		0.1692		
			(5.079)		(3.169)		
Democracy index squared					-0.0250		
					(-3.800)		
Democratic since 1950					0.3174		-0.1824
					(3.823)		(-1.481)
Press freedom							-0.0057
							(-3.256)
Log inflation					0.1071		
					(4.601)		
Terms of trade shocks				-0.1007		0.2284	
				(-1.561)		(9.520)	
Log air distance				-9.6492	-0.0431		0.1637
				(-3.249)	(-1.898)		(2.414)
Log area				-2.6226			
				(-2.025)			
Landlocked				-1.6930		-0.3498	0.3513
				(-0.293)		(-0.346)	(2.297)
Island				-0.3014	0.2448	-2.1798	
				(-0.068)	(3.081)	(-2.723)	
*R*²	0.211 0.171	0.524 0.564	0.774 0.796	0.434 0.387	0.273 0.358	0.488 0.623	0.579 0.601
	0.185 0.020	0.640 0.606	0.794 0.789	0.311 0.310	0.330 0.217	0.460 0.482	0.607 0.611

Notes: Number of countries: 81. In parentheses, *t*-statistics based on heteroskedastic-consistent (White-robust) standard errors are reported. All variables are described within the text and appendix. R^2 is reported for the each of the four time period per equation.