Ratbek Dzhumashev*

The Role of Income Uncertainty in the Corruption–Growth Nexus

DOI 10.1515/bejeap-2015-0056

Published online February 19, 2016

Abstract: This paper analyses how corruption-induced income uncertainty affects the relationship between corruption and economic growth. The analysis reveals both the growth-enhancing and deteriorating effects of corruption that transmit through the income and productivity channels, and shows how income uncertainty caused by corruption interacts with both of these effects. In particular, it is found that an increase in bribe rates and the probability of corruption that reduces the burden of regulations generate counteracting effects on income and productivity, where both effects are further aggravated by corruption-induced income uncertainty. On the other hand, a higher burden of bribes imposed by extortive bureaucrats hampers growth unambiguously. However, in a highly corrupt environment, an increase in the incidence of extortive behaviour can be growth enhancing as it reduces income uncertainty, while if corruption levels are relatively low, then a further increase in the incidence of such behaviour deteriorates growth. These findings give us a new insight into why the overall growth effect of corruption is ambiguous.

Keywords: corruption, growth, income uncertainty

1 Introduction

Corruption is defined as the misuse of a public position by bureaucrats to create and capture private rents. This behaviour affects the quality and quantity of services and infrastructure provided by the government, both of which are essential inputs to private production.¹ The extant literature has pointed out that by creating inefficiencies in public sector activities, corruption emerges as a significant factor affecting the growth potential of the economy as well as the

¹ The seminal papers by Barro (1990) and Barro and Sala-i Martin (1992) propose that government services can be treated as a productive input. Further extensions of Barro's model by Futagami, Morita, and Shibata (1993), Turnovsky (1996), Tsoukis and Miller (2003) and Chen (2006) show the importance of the public sector in economic growth.

***Corresponding author: Ratbek Dzhumashev**, Department of Economics, Monash University, 100 Clyde Road, Berwick, Victoria 3806, Australia, E-mail: Ratbek.Dzhumashev@monash.edu

welfare of the society.² Although the impact of corruption through distortions in the activities of the public sector has been analysed in the existing literature, how the income uncertainty caused by corruption affects growth has not been explicitly modelled in literature. In view of this, the primary aim of this paper is to integrate income uncertainty into the corruption–growth relationship and obtain new insights into how corruption alters the effect of government on economic growth.

Due to their illicit nature, outcomes of corrupt deals are generally not enforceable. This naturally gives rise to the uncertainty associated with corruption (e. g. Blackburn and Forgues-Puccio 2009; Ryvkin and Serra 2012; Shleifer and Vishny 1993), which in turn, affects the uncertainty of income. In this regard, the importance of incorporating corruption-induced uncertainty in determining the overall effects of corruption has been widely emphasized in the literature. For example, Shleifer and Vishny (1993), Blackburn and Forgues-Puccio (2009) and Ehrlich and Lui (1999) argue that by reducing income uncertainty, more organized corruption practices can lead to a decreased burden on the economy, and thus, improve economic efficiency.

There is empirical evidence corroborating how corruption has a significant effect on income uncertainty. For example, based on a cross-country data, Evrensel (2010) finds that higher corruption incidence increases growth volatility, whereas Goel and Ram (2013) argue that economic uncertainty has a positive association with corruption. Campos, Lien, and Pradhan (1999) studying firm survey data have established that the predictability of corruption can have a comparable effect on the investment decision to that of a lower incidence of corruption. In line with this reasoning, Fisman and Gatti (2006) analysing the data from World Business Survey find that uncertainty is an important factor that drives the amount of time a firm spends on bureaucratic hassles. Corroborating them, Rock and Bonnet (2004), and Kuncoro (2006) find that the predictability of corruption outcomes is a crucial factor that drives investment and other business activities in East Asian economies, whereas Sequiera and Djankov (2014) find that uncertainty in bribe levels reduces demand for corrupt public service. Wei (1997) studies the effect of income uncertainty on foreign direct investment (FDI) and finds that corruption-induced uncertainty has a significant negative impact on FDI. However, despite this highlighted importance, little effort has been directed towards understanding how income uncertainty induced by corruption affects the productivity and income of the private agents.

² See *inter alia* de Vaal and Ebben (2011), Mauro (1995, 2004), Mo (2001), Pellegrini and Gerlagh (2004) and Shleifer and Vishny (1993).

There is a sizeable body of research dedicated to studying economic effects of corruption. In this literature, it has been highlighted that corruption in the public sector alters private income by imposing the burden of bribes (Hunt 2007; 2004; Mocan, 2008; Svensson 2003; Fisman and Svensson 2007; and Polinsky and Shavell 2001) and affects private productivity by distorting the positive externalities provided by government spending (Mauro 1998; Tanzi and Davoodi 2000; Shleifer and Vishny 1993; Rajkumar and Swaroop, 2008; Delavallade 2006; Keefer and Knack, 2002; Abed and Gupta 2002; Dzhumashev 2014a, 2014b; Hessami 2014). Overall, these impacts of corruption on private outcomes have significant implications on economic growth (see Del Monte and Papagni 2001; Mauro 2004; Blackburn, Bose, and Haque 2010; Blackburn, Bose, and Haque 2006; Barreto 2000; Barelli and Pessoa 2012; Kaufmann and Wei 1999; Dzhumashev 2014a). Nevertheless, the impact of corruption on economic growth has not been studied based on a cohesive set-up that incorporates the income uncertainty effects of corruption. This paper extends the analysis of corruption by incorporating the impact of corruption-induced uncertainty on income and productivity through the private–public sector nexus.

In addition, this richer structure of the model will help to shed a new light on the controversial hypotheses about whether “corruption is grease-on-wheels” versus whether “corruption is sand-on-wheels” (e. g. Aidt 2009; Dreher and Gassebner 2013; Méon and Sekkat 2005; Méon and Weill 2010; Méndez and Sepúlveda 2006; Kaufmann and Wei 1999). Overall, the aforementioned literature indicates that the rent-seeking of corrupt bureaucrats results in both efficiency-enhancing and efficiency-deteriorating effects.³ In fact, the conditions under which one of the mentioned effects would dominate have not been extensively analysed in literature. To address this issue, it appears logical to consider the effects of corruption of both forms: coercive and collusive.⁴ Coercive corruption occurs when bureaucracy bundles public services with excessive red tape, coercing private agents to pay bribes to the bureaucrat in order to access the public service. Collusive corruption, on the other hand,

³ For example, Leff (1964) suggests that corruption that decreases red tape can be beneficial for economic growth. Similar views are shared by Huntington (1968) and Lui (1985, 1996). They view corruption as an optimal response to market distortions that lessens the burden of regulations, and thus, improves efficiency. In line with this reasoning, Méon and Weill (2010) and Méndez and Sepúlveda (2006) find some empirical evidence that corruption can have a positive effect on growth, whereas Dreher and Gassebner (2013)

show that higher corruption leads to a smaller shadow economy, by reducing the negative impact of regulations.

⁴ See Shleifer and Vishny (1993) and Sequiera and Djankov (2014) for a detailed explanation of these two types of corruption.

occurs only after the interaction between the private and public agents has taken place. It usually involves a situation where the public agent obtains some information about the private agent's failure in abiding the law or regulation. As illegal activities, both types of corruption are associated with risk, and hence, lead to income uncertainty. Therefore, to obtain deeper insights into the efficiency aspects of corruption, it will be helpful to consider this type of income uncertainty jointly and evaluate changes in income and productivity of agents caused by both types of corruption.

The analysis in this paper is based on a two-sector model: a high- and low-productivity sector. In this respect, the approach is similar to Coppier and Michetti (2006), Li, Xu, and Zou (2000) and Blackburn and Wang (2009) who have used a similar two-sector (low- and high-productivity) model to study the relationship between corruption and production. In this paper, for simplicity, it is assumed that the public sector is involved only in the high-productivity (modern) sector, due to licensing and regulation imposed on this sector. Another distinct feature of this study is that the model we employ has distinct and important differences from the models used in the closely related papers. In particular, Wei (1997) assumes that corruption-induced income uncertainty is exogenous; hence, the relationship between corruption-induced income uncertainty and the incidence of corruption is not explained at all. On the other hand, Blackburn and Wang (2009) consider corruption-induced income uncertainty; however, how income uncertainty is linked to both the burden and incidence of corruption is not captured. By contrast, the analysis in this paper builds on the micro-level interactions between private and public agents, and corruption-induced income uncertainty is modelled explicitly, along the lines of stochastic models (Dixit and Pindyck 1994; Chang 2004). Specifically, income uncertainty is captured as random income shocks stemming from illicit transactions between private and public agents. The advantage of this approach is that it allows us to link directly income uncertainty to both the burden and incidence of corruption, which was not featured in previous papers. Finally, this paper extends on the model used by Dzhumashev (2014a, 2014b) that accounts for both coercive and collusive forms of corruption, by incorporating the corruption-induced income uncertainty and allowing for productivity differentials in a two-sector economy.

The primary findings of this study are summarized as follows. First, the results show that the overall growth effect of corruption depends on the trade-off between the effects of the income and productivity shocks caused by corruption, and whether corruption results in more or less income uncertainty for the private agent; hence, it may be positive or negative. Second, the paper demonstrates that corruption-induced income uncertainty not only adversely affects the economy (as in Blackburn and Wang 2009; Shleifer and Vishny 1993; Wei 1997) but

also reinforces the direct effect of corruption, as it increases together with the burden of bribes. Third, it is found that the relationship between the incidence of collusive corruption and income uncertainty is negative, as an increase in the probability of collusive corruption unambiguously reduces income uncertainty. Fourth, it is found that the relationship between the probability of coercive corruption and income uncertainty is non-linear and of an inverted U-shape. Importantly, this finding implies that anti-corruption measures should differentiate between high- and low-incidence environments, as the effect of an increase in the probability of coercive corruption differs depending on the extent of its incidence. Finally, by showing that income uncertainty induced by coercive corruption depends on some threshold level of incidence, the above result offers additional support to the proposition that relates the effect of corruption to its frequency. In other words, widespread corruption generates externalities of corruption culture, not only by reducing the cost of corrupt behaviour, as suggested in the literature,⁵ but also by decreasing the income uncertainty faced by private agents. The above result indicates that, when the incidence of coercive corruption is high, coercive corruption persists also as it lowers the income uncertainty of private agents.

The main empirical implication of the results obtained in the paper is that it suggests an analytical explanation for the non-linearity of the growth effect of corruption (e.g. Swaleheen 2011) through establishing a concave relationship between income uncertainty and corruption. Moreover, it has been found that the non-linear growth effects of corruption are conditional on the quality of institutions (see Méndez and Sepúlveda 2006; Aidt, Dutta, and Sena 2008; Méon and Sekkat 2005; Méon and Weill 2010). Given that in an environment with institutions of poor quality, the uncertainty associated with corruption increases, these empirical findings can be linked to uncertainty induced by corruption. One can also relate the findings of this study to the empirical results by Dreher and Gassebner (2013), who find that corruption can help increase firm entry through distortions of regulations. If the measure of corruption used in their estimations reflects the incidence of corruption rather than its burden through bribes, then the above results indicate that after some threshold levels, corruption can facilitate firm entry by reducing the income uncertainty faced by the firms. This implies that in empirical analyses of the effect of corruption on market entry, one needs to differentiate the effect of corruption stemming from its incidence and the burden of bribes. In addition, the non-linearity of the relationship between the incidence of coercive corruption and income

⁵ See Andvig and Moene (1990), Blackburn, Bose, and Haque (2006), Qulea and Fulton (2009) and Haque and Kneller (2009).

uncertainty still needs to be ascertained empirically, and whether this non-linear relationship have impacts on market entry and growth of firms remains to be established.

The rest of the paper is structured as follows: in Section 2, the set-up of the model is described, and its implications are analysed based on the optimality conditions. In Section 3, the equilibrium analysis results are presented. The last section concludes the paper.

2 The Model

2.1 Background

In literature, corruption is classified as *ex ante* or coercive and *ex post* or collusive.⁶ Coercive corruption occurs in the provision of public services that require red tape. In this case, corrupt bureaucracy bundle public services with excessive red tape, in turn coercing private agents to pay bribes to the bureaucrat in order to access the public service. The extent of such extortion depends on the strength of the rule of law and judicial system in the economy. Usually this type of corruption leads to bottlenecks (long queues) and shortages of public goods and services. Thus, only those who find it beneficial will pay the bribes and obtain the public service. Essentially, this means that the bureaucrats extort bribes from the private agent involved in the high-productivity sector by abusing their power to license and audit. The rationale here is that enterprises in the high-productivity sector are usually large and are located in urban centres with developed infrastructure, thereby making the producer easily detectable by the government. The high detectability and income-generating capacity of such enterprises are likely to be the main motivation for imposing government regulation and red tape upon them. Of course, the traditional sector might also be regulated to some extent, but for the purpose of our analysis, what matters is that the modern sector is regulated relatively more than the traditional sector. This is because, at the margin, the decision to participate in high-productivity sector activities depends on the difference in regulatory costs between traditional and modern sectors. Thus, to simplify the analysis we will assume that only the high-productive sector is regulated.

⁶ See e.g. Shleifer and Vishny (1993) and Sequiera and Djankov (2014) on the taxonomy of corruption.

Along the lines of the rationale for the aforementioned assumption about the high-productive sector being regulated and its relation with corruption, Bates (1981) argued that in Africa farmers are staying in the subsistence farming to avoid corruption they are subjected when entering markets. Beekman et al. (2013) find an empirical support for the foregoing hypothesis based on micro-data from Liberia. To study the effects of rent-seeking, Murphy, Shleifer, and Vishny (1993) proposed a model with two different productivity levels, where only market-oriented production is subject to rent-seeking. Following a similar rationale, Coppier and Michetti (2006), Blackburn and Wang (2009), Li, Xu, and Zou (2000) and Foellmi and Oechslin (2007) consider a model where an agent can produce in either the traditional or the modern (low- and high-productivity) sector model to study the relationship between corruption and production.⁷

Collusive corruption, on the other hand, only occurs after the interaction between the private and public agents has taken place. It usually involves a situation where the public agent obtains some information about the private agent's failure in abiding by the law or regulation. Consequently, to avoid the penalty for the infringement, the private agent is willing to pay bribes to the public agent. If the public agent is corrupt, then he accepts bribes and conceals the infringement. Thus, a corrupt deal only occurs if it is beneficial for both the public and the private agents. For example, such a situation may arise as a result of tax evasion and the corruption associated with it.

2.2 The Environment

Let us consider a closed economy with *ex ante* identical infinitely lived agents and zero population growth. Each agent has a measure of utility defined by a function on private consumption, c . The instantaneous utility function is given by

$$u(c) = \ln(c). \quad [1]$$

The agents maximize their expected utility,

⁷ The possibility of a positive relationship between corruption and productivity has been suggested by several studies. For example, Svensson (2003) finds that firms with higher profits also pay more bribes. Thus, the impact of corruption on firms appears to increase with their income, because bureaucrats extorting bribes discriminate between high- and low-productivity agents. Along these lines, Broadman and Recanatini (2002), Djankov et al. (2002) and Svensson (2005) find a strong correlation between higher barriers to market entry and the level of corruption.

$$U(0) = \mathbb{E}_0 \left\{ \int_0^{\infty} \ln(c(t)) \exp(-\rho t) dt \right\}, \quad [2]$$

where ρ is the constant rate of time preference. In the forthcoming discussion, the time argument is omitted, when it does not distort the underlying idea.

The production technology is of two types: low and high productivity. Let y_1 and y_2 , k_1 and k_2 be per worker output and capital in the respective sectors; and $k = k_1 + k_2$. In the low-productivity case, the production function is given as

$$y_1 = Bk_1 = B(k - k_2). \quad [3]$$

In the high-productivity sector, the production function is expressed as,

$$y_2 = \tilde{A} k_2. \quad [4]$$

As in Barro (1990), it is assumed that public spending contributes to productivity of the private sector, albeit only in the high-productivity sector. Thus, $\tilde{A}$ is a function of g , per worker public spending. In general, it can be expressed as $\tilde{A} \equiv A \varphi(g)$, but as a specific form it can be assumed that

$$\varphi(g) = g^{\delta}, \quad [5]$$

where δ is the output elasticity of the public input, $0 < \delta < 1$, and, B and A are the technology coefficients in the low- and high-productivity sectors, respectively. These coefficients are assumed to be exogenous.

The government imposes a flat income tax rate, τ , on the income generated in the high-productivity sector, and uses the revenue to produce the productive public input, g . The public spending is assumed to cover all the costs of the productive input, g , including the salaries of the bureaucrats. The tax revenue, in per worker terms, is given by $(1-e)\tau y_2$, where e measures the tax evasion rate, $e \in (0,1)$. To capture the inefficiency in the public sector one can assume that the public input is expressed as

$$g = v(1-e)\tau y_2, \quad [6]$$

where v is the efficiency coefficient ($v \in (0,1]$), which depends on the quality of governance (Blackburn, Bose, and Haque 2010; Del Monte and Papagni, 2001; de Vaal and Ebben 2011; Mauro 2004).

In the model economy, two types of corruption occur. Collusive corruption takes place when the bureaucrats and taxpayers collude to conceal tax evasion. Whilst coercive corruption occurs when private agents enter the high-productivity sector, enabling them to obtain public services and access infrastructure, but also making them subject to extortion by the predatory bureaucrats. An optimizing agent allocates the capital stock between the high-productivity and

low-productivity sectors. The share of capital stock used in the high-productivity sector is denoted by n ; $0 < n < 1$. Then, given that k is the total capital stock owned by the agent, the allocation of capital between the sectors is given as follows: the capital employed in the low-productivity sector is $k_1 = (1-n)k$, while the capital used in the high-productivity sector is $k_2 = nk$.

2.2.1 Collusive Corruption

Agents evade taxes to increase their disposable income by under-reporting their true income. It is assumed that the private agent reports only $(1-e)y_2$ of the income generated in the high-productivity sector, and that $0 < e < 1$ holds. There is an auditing mechanism in place to combat tax evasion. The joint probability of being audited and detected is given exogenously by π . The detected evader pays back the due tax liability and some additional fine. This penalty is determined by a penalty rate $\theta = 1 + s$, which includes the tax evaded and a surcharge, s .

It is well known that modelling tax evasion without the friction or costs associated with it leads to the so-called Yitzhaki puzzle. The essence of this puzzle is that in such models, an increase in the tax rate leads to a reduction of tax evasion, which is not confirmed by the data.⁸ One way of addressing this inconsistency is suggested by Chen (2003), who incorporates the cost of tax evasion into the decision-making process of the tax evader. These costs may include hiring experts and lawyers to conceal illegal income; for example, costs such as the transaction costs involved in tax evasion, as explained by Cowell (1990) and Chen (2003). Chen (2003) captures this cost as a function that depends on the tax evasion rate. Following this literature, it is also assumed that tax evasion incurs costs proportional to the evaded income, ηey_2 , with η being a cost parameter.

A tax inspector, who conducts audits, is corruptible with a probability π_1 . Further, to exclude trivial cases with no corruption, only the environments where the probability of the tax inspector being corrupt are considered and it is assumed that $0 < \pi_1 < 1$ holds. Thus, with corruption, the effective penalty rate faced by the taxpayer is given as

$$\theta_1 = \begin{cases} \theta & \text{with probability } 1 - \pi_1, \\ b_1 & \text{with probability } \pi_1, \end{cases} \quad [7]$$

⁸ See Dzhumashev and Gahramanov (2010, 2011), Levaggi and Menoncin (2013, 2012) and Yitzhaki (1974).

where $b_1 < \theta$ is the bribe rate. Therefore, the expected value of the random penalty rate is given as

$$\mathbb{E}[\theta_1] \equiv \bar{\theta} = \pi_1 b_1 + (1 - \pi_1) \theta. \quad [8]$$

The randomness of both the audit and corruption outcomes implies that the after-tax income with evasion and audit is a random variable given by the following trinomial distribution:

$$y_\tau = \begin{cases} y_1 + (1 - \tau)y_2 + \tau ey_2 - \eta ey_2 & \text{with probability (w. p.) } p_1 = (1 - \pi), \quad (\text{no audit}) \\ y_1 + (1 - \tau)y_2 + (1 - b)\tau ey_2 - \eta ey_2, & \text{w. p. } p_2 = \pi\pi_1, \quad (\text{audit, corruption}) \\ y_1 + (1 - \tau)y_2 + (1 - \theta)\tau ey_2 - \eta ey_2, & \text{w. p. } p_3 = \pi(1 - \pi_1), \quad (\text{audit, no corruption}) \end{cases} \quad [9]$$

It is clear that the expected amount of the after-tax income shock is equal to

$$\mathbb{E}[dy_\tau] = \tau ey_2 \mathbb{E}[x_1], \quad [10]$$

where $\mathbb{E}[x_1]$ is the mean of the random return to a unit of evaded tax. The expected return to a unit of evaded tax is

$$\mathbb{E}[x_1] = \sum_{i=1}^3 p_i x_{1i}. \quad [11]$$

Based on eqs [8] and [9] it can be written as

$$\bar{x}_1 = \mathbb{E}[x_1] = 1 - \pi \bar{\theta}, \quad [12]$$

whereas the variance of the return on tax evasion is given by

$$\varsigma_1^2 = \mathbb{E}[x_1^2] - (\mathbb{E}[x_1])^2 = \pi(1 - \pi)(\bar{\theta}\tau)^2. \quad [13]$$

It should be highlighted that if the agents were risk-neutral then they would care only about the expected value of the income shocks. However, here we are focusing on the case where agents also care about the uncertainty captured by the variance of the income shocks, implying that the agents are risk-averse.

2.2.2 Coercive Corruption

When private agents enter the high-productivity sector they are subjected to coercive corruption. Since the private agent involved in the high-productivity sector has to deal with corrupt bureaucracy, it is assumed that the agent pays bribes with some given probability. It is clear that there may be a myriad of different ways in which the bureaucrats can extort bribes from the private agent.

However, for the sake of tractability, it is supposed that the bureaucrat extorts zero bribes with probability, $1-\pi_2$, and b_2 bribes with probability, π_2 , where $b_2 > 0$.

This binomial distribution has the following mean:

$$\bar{x}_2 = b_2\pi_2, \quad [14]$$

and the following variance,

$$\varsigma_2^2 = \pi_2(1-\pi_2)b_2^2. \quad [15]$$

Now, the combined impact of coercive and collusive corruption on the private agent's income can be formulated. Recall that the amount of income obtained after tax with evasion is given by eq. [12], reducing this by the amount of the expected bribe paid in coercive corruption deals, gives us the effective disposable income generated in the high-productivity sector:

$$y_{2d} = (1 - \tau - \bar{x}_2 - \eta e + \bar{x}_1 \tau e) y_2. \quad [16]$$

2.2.3 Corruption and Income Uncertainty

Based on the above discussions, the following propositions that relate income uncertainty with corruption can be stated.

Proposition 1: *An increase in the bribe rate of both types of corruption raises income uncertainty. An increase in the bribe rate of collusive corruption reduces the rate of return to evasion, $\bar{x}_1$, whereas an increase in the bribe rate of coercive corruption raises the expected burden, $\bar{x}_2$.*

Proof: From eq. [8], $\bar{\theta} = \pi_1 b_1 + (1 - \pi_1)\theta$, it can be verified that an increase in the bribe rate, b_1 , raises directly $\bar{\theta}$. Observing eq. [13], $\varsigma_1^2 = \pi_1(1 - \pi_1)(\bar{\theta}\tau)^2$, one can establish that this leads to an increase in the variance, ς_1^2 . From eq. [15], $\varsigma_2^2 = \pi_2(1 - \pi_2)b_2^2$, it is clear that for any given distribution of corruption outcomes, an increase in the level of the bribe rate, b_2 , raises income uncertainty measured by ς_2^2 . From eq. [11], $\bar{x}_1 = 1 - \pi\bar{\theta}$ and eq. [8], $\bar{\theta} = \pi_1 b_1 + q_1\theta$, one can verify that $\frac{\partial \bar{x}_1}{\partial b_1} < 0$. Similarly, from eq. [14], $\frac{\partial \bar{x}_2}{\partial b_2} > 0$ can be verified. ■

The intuition behind this result is simple. More bribes demanded by the bureaucrat in both types of corruption mean that the expected loss due to corruption becomes larger, and hence, the variability of disposable income increases. Proposition 1 shows that the income uncertainty caused by corruption aggravates the negative impact of corruption on the economy, as it increases together

with the burden of bribes. Thus, higher bribe rates not only increase the burden of corruption, but also lead to greater income uncertainty.

Next proposition relates the probability of corruption and income uncertainty.

Proposition 2: *An increase in the probability of collusive corruption, π_1 , raises the return to evasion, $\bar{x}_1$, but reduces income uncertainty, ς_1^2 , induced by this form of corruption. An increase in the probability of coercive corruption, π_2 , raises the burden, $\bar{x}_2$, and reduces income uncertainty, ς_2^2 , if $\pi_2 > 1/2$, but raises income uncertainty, if $\pi_2 < 1/2$.*

Proof: Recall from eqs [8], [11] and [13] that $\bar{x}_1 = 1 - \pi[\pi_1 b + (1 - \pi_1)\theta]$ and $\varsigma_1^2 = \pi(1 - \pi)[\pi_1 b_1 + (1 - \pi_1)\theta]^2 \tau^2$. Then, it is straightforward to verify that $\frac{\partial \bar{x}_1}{\partial \pi_1} > 0$ and $\frac{\partial \varsigma_1^2}{\partial \pi_1} < 0$. Next, recall from eqs [14] and [15] that $\bar{x}_2 = b_2 \pi_2$ and $\varsigma_2^2 = (\pi_2 - \pi_2^2) b_2^2$. Now, it can be shown that $\frac{\partial \bar{x}_2}{\partial \pi_2} > 0$, and $\frac{\partial \varsigma_2^2}{\partial \pi_2} < 0$ if $\pi_2 > 1/2$, and $\frac{\partial \varsigma_2^2}{\partial \pi_2} > 0$ if $\pi_2 < 1/2$. ■

The above finding indicates that anti-corruption measures should differentiate between high- and low-incidence environments, as the effect of an increase in the probability of coercive corruption may lead to either a rise or fall of income uncertainty depending on the extent of its incidence. In the case with collusive corruption, the higher probability of corruption increases the expected return on tax evasion, but reduces the magnitude of the income uncertainty associated with it. On the other hand, the variance of the income shock stemming from coercive corruption is a concave function of the probability of corruption. Therefore, when an increase in the probability of coercive corruption results in an increase of both the expected burden of bribes and the income uncertainty associated with such corruption, one would expect a negative effect on growth. Even if, an increase in the probability of coercive corruption leads to lower income uncertainty, the growth effect of such a change remains unclear. This is because the positive effect of the reduced income uncertainty is offset by the negative effect of the higher expected burden of bribes. An important implication of Proposition 2 is that it demonstrates that there is an inverted U-shaped relationship between the incidence of coercive corruption and the income uncertainty induced by it; whereas the relationship between the bribe rate in coercive corruption and income uncertainty is monotonically negative.

There is some evidence that supports the results reported above. Notably, Evrensel (2010) and Goel and Ram (2013) empirically study the relationship

between corruption and uncertainty and find that they are positively related. However, they did not ascertain the non-linear relationship between income uncertainty and corruption levels explicitly. It appears that one way to relate the uncertainty and corruption in a non-linear manner is through the quality of institutions. That is, in the environment with weak institutions corruption becomes widespread and more predictable, hence reducing income uncertainty associated with corruption. In this light, the above analytical finding about the relationship between corruption and income uncertainty is in line with the empirical results by Méndez and Sepúlveda (2006), Aidt, Dutta, and Sena (2008), Méon and Sekkat (2005) and Méon and Weill (2010). These authors find that in countries with poor institutions (weak governance) the marginal effect of corruption on growth is positive (or neutral), whereas with strong institutions the effect is negative. In other words, this non-linear effect of corruption is likely to reflect the above-mentioned inverted U-shaped relationship between income uncertainty and coercive corruption. The non-linear relationship between coercive corruption and uncertainty corroborates the results established by Swaleheen (2011), who finds that the growth effect of corruption is non-linear and it changes from negative to positive at some high levels of its incidence. One reason for this non-linearity can be a fall in the income uncertainty induced by corruption after its incidence reaches some threshold levels.

2.3 Stochastic Income

The above description of the interactions between corrupt bureaucrats and private agents identifies that there are two sources of uncertainty that affect the incomes of private agents. In order to capture the effect of this uncertainty we need a method that can incorporate the mean as well as the variance of the income shocks. This can be done using stochastic differential equations that are derived as a continuous limit of a discrete-time problem (see e. g. Dixit and Pindyck 1994). The following is a discussion of how these income shocks are formulated in the form of a stochastic Brownian motion, which then allows for the methods of Stochastic Calculus to solve the households' optimization problem.

First, let us start with the income shocks stemming from collusive corruption. Section 2.2.1 outlines that these shocks follow a trinomial distribution. It should also be noted that this is a single-state stochastic process, as all three different outcomes are related to the income of the same individual. Here one can follow Kamrad and Ritchken (1991) who show how to approximate a discrete trinomial distribution of a single-state process by some limiting continuous

normal distribution.⁹ The basic idea of this method is as follows. First, one needs to find the mean and variance of the trinomial distribution of the random variable, x , then equate them to the unknown parameters of the normal distribution as follows:

$$\mathbb{E}[x] = \sum_{i=1}^3 p_i x_i = \mu \Delta t, \quad [17]$$

$$\zeta_1^2 = \mathbb{E}[x^2] - (\mathbb{E}[x])^2 = \sigma_1^2 \Delta t. \quad [18]$$

Then setting the step size of this trinomial distribution for an infinitesimal increment Δt as $\Delta \xi = \lambda \sigma_1 \sqrt{\Delta t}$, $\lambda \geq 1$, and using the condition $\sum_{i=1}^3 x_i = 1$ as the third equation, together with eqs [17] and [18], and solving for p_i , $i \in 1, 2, 3$ yields the approximating relationship between the discrete distribution and the continuous normal distribution. Appendix A1 presents the derivation of the probabilities of this trinomial distribution in terms of the parameters of the approximating normal distribution.

Given this approximation, a stochastic change of income generated per unit of tax evaded is given by the following stochastic differential equation:

$$dx_1 = \mu_1 dt + \sigma_1 dz, \quad [19]$$

where μ_1 and σ_1 are positive parameters, respectively, capturing the mean and volatility, and z is a standard Brownian motion where its increment, dz , has zero mean and variance, dt .

Now, let us consider the income shocks stemming from coercive corruption. As it is shown above, coercive corruption leads to outcomes that are binomially distributed. This binomial process, similar to the trinomial distribution in the case of collusive corruption, also converges to some limiting normal distribution with mean μ_2 and variance σ_2^2 . The approximation of the binomial distribution with the parameters of the normal distribution are done in a similar manner to the trinomial distribution case discussed above.¹⁰ In light of the above approximation, the instantaneous random income shock per unit of income caused by coercive corruption can be written as

⁹ In the Probabilistic Distribution Theory literature, the type of random variables of the form, $\{X_{nk}, k = 1, \dots; n = 1, \dots\}$, is referred to as the triangular arrays. Particularly, in our case we have the following triangular array: $\left(\begin{array}{l} X_{11} - \text{no audit} \\ X_{21} - \text{audit, corruption; } X_{21} - \text{audit, no corruption} \end{array} \right)$. See, for example, Severini (2005, 367–71) for a rigorous explanation and proofs of the normal approximation of random variables of this type.

¹⁰ One can see the details of the derivation in Dzhumashev and Gahramanov (2011) and Lin and Yang (2001).

$$dx_2 = \mu_1 dt + \sigma_2 dz. \quad [20]$$

Due to the Central Limit Theorem (see, e. g. Severini 2005), changes in the discrete probability distributions lead to similar changes in the approximating continuous distribution. This implies the following corollary.

Corollary 1: *The results of Propositions 1 and 2 with respect to the discrete distribution parameters are also applicable to the parameters of the approximating continuous distributions.*

2.3.1 Stochastic Income and the Budget Constraint

After incorporating the income shocks, described above, to the initial income of the agent stemming from both the high- and low-productivity sectors, the total stochastic shock can be expressed as

$$\sigma dv = \sigma_1 \tau e dz + \sigma_2 dz.$$

This implies that the variance of the total shock is given by

$$\sigma^2 = (\tau e \sigma_1)^2 + 2\tau e \sigma_{12} + \sigma_2^2.$$

One can assume that there is no correlation between the two income shocks, as taxation and other red tape-related regulations are implemented by different bureaucrats. That is, given $\sigma_{12} = 0$ implies that $\sigma^2 = (\tau e \sigma_1)^2 + \sigma_2^2$, and thus, one can write the budget equation as a stochastic differential equation:

$$dk = [(1 - \tau - \mu_2 - \eta e + \mu_1 \tau e)y_2 + y_1 - c]dt + (\sigma_1 \tau e + \sigma_2)y_2 dz, \quad [21]$$

where y_1 is the income generated in the low-productivity sector, the term $[(1 - \tau - \mu_2 - \eta e + \mu_1 \tau e)y_2 + y_1 - c]dt$ is the expected part of this random income, and the terms, $\sigma_1 \tau e y_2 dz$ and $\sigma_2 y_2 dz$ are the stochastic shocks to income, stemming from the two types of corruption.

2.4 The Household's Optimization

In line with Barro (1990) and Chen (2003), the household's problem is set up as the second- best welfare maximization problem. An individual household maximizes its expected overall utility, U , by taking π , π_1 , π_2 , b_1 , b_2 , θ , τ and g as given and by choosing the consumption level, c , the tax evasion rate, e , and capital allocation, k_2 , subject to a stochastic budget constraint:

$$\max_{c, e, k_2} U = \mathbb{E}_0 \int_0^\infty \ln(c(t)) \exp(-\rho t) dt, \quad [22]$$

$$\text{s.t. } dk = [(1 - \tau - \mu_2 - \eta e + \mu_1 \tau e) y_2 + y_1 - c] dt + (\sigma_1 \tau e + \sigma_2) y_2 dz, \quad [23]$$

$$0 \leq c \leq (1 - \tau - \mu_2 - \eta e + \mu_1 \tau e) y_2 + y_1, \quad 0 \leq k, \quad k(0) = k_0, \quad [24]$$

$$0 \leq e \leq 1. \quad [25]$$

This problem is solved by satisfying the following Bellman equation:¹¹

$$\begin{aligned} \rho I(k) = \max_{c, e, k_2} \{ & \ln(c(t)) + I'(k) [(1 - \tau - \mu_2 - \eta e + \mu_1 \tau e)] A \varphi k_2 + B(k - k_2) - c \} \\ & + \frac{1}{2} I''(k) (A \varphi k_2)^2 [(\sigma_1 e \tau)^2 + \sigma_2^2] \}, \end{aligned} \quad [26]$$

where $I(k) = \max_{c, e, k_2} \mathbb{E}_0 \{ \int_0^\infty \ln(c) \exp(-\rho t) dt \}$ is the value function that is subject to eqs [23], [24] and [25], and $\mathbb{E}_0$ is the conditional expectation operator for a given initial value of capital, $k(0) = k_0$. In the Bellman equation, the y_1 and y_2 are substituted with the production functions given in eqs [3] and [4], and φ from eq. [5].

Using the first-order conditions (FOC) of the Bellman eq. [26] and the envelope condition the following is derived:

$$c(t) = \frac{1}{I'(k)}, \quad [27]$$

$$e(t) = - \frac{I'(k) [\mu_1 \tau - \eta]}{I''(k) \sigma_1^2 \tau^2 A n \varphi k}, \quad [28]$$

$$k_2(t) = - \frac{I'(k) [(1 - \tau - \mu_2 - \eta e + \mu_1 \tau e) A \varphi - B]}{I''(k) (A \varphi)^2 [(\sigma_1 e \tau)^2 + \sigma_2^2]}. \quad [29]$$

A standard general solution of this differential equation can be expressed in the following form, $I(k) = \frac{\ln(k) + C}{\rho}$. A substitution for $I(k)$ in eqs [27], [28], and [29] leads to:

$$c(t) = \rho k, \quad [30]$$

$$e(t) = \frac{\mu_1 \tau - \eta}{\sigma_1^2 \tau^2 A n \varphi}, \quad [31]$$

$$k_2(t) = \frac{[1 - \tau - \mu_2 + \mu_1 \tau e - \eta e] A \varphi - B}{(A \varphi)^2 [\sigma_1 e \tau]^2 + \sigma_2^2}. \quad [32]$$

¹¹ See Chang (2004) for the details of this method.

Further, solving eqs [31] and [32] together yields the following equilibrium expressions:

$$e^* = \frac{(\mu_1\tau - \eta)A\varphi\sigma_2^2}{[(1 - \tau - \mu_2)A\varphi - B]\sigma_1^2\tau^2}, \quad [33]$$

$$k_2^* = \frac{(1 - \tau - \mu_2)A\varphi - B}{(\sigma_2A\varphi)^2}. \quad [34]$$

Given the equilibrium value of k_2 , the capital shares in the two sectors can be written as

$$\frac{k_2^*}{k} \equiv n = \frac{(1 - \tau - \mu_2)A\varphi - B}{(\sigma_2A\varphi)^2k}, \quad [35]$$

$$\frac{k_1^*}{k} = 1 - n. \quad [36]$$

2.4.1 Growth Rate

From eq. [30], one can establish that the optimal growth path requires that the agent consumes a fixed proportion of the capital stock. This implies that given the AK-type production function, on the balanced growth path the growth rates of consumption, capital accumulation and output should be the same. Thus, in such an economy the following growth conditions should hold:

$$\gamma = \frac{\dot{c}}{c} = \frac{\dot{k}}{k} = \frac{\dot{y}}{y}.$$

Therefore, finding the growth rate of capital accumulation will be enough to express the growth rate of the economy. This growth rate will be equal to the expected part of the stochastic growth rate of capital,

$$\gamma = \mathbb{E}\left(\frac{dk}{k}\right).$$

By substituting the optimal value for consumption from eq. [30] in eq. [21] and denoting by n and e^* the equilibrium values of the capital share in the high-productivity sector and the tax evasion rate correspondingly, one can find that the per capita growth rate is given as

$$\gamma = \mathbb{E}\left(\frac{dk}{k}\right) = [(1 - \tau - \mu_2 + \mu_1\tau e^* - \eta e^*)A\varphi n + (1 - n)B - \rho]. \quad [37]$$

2.5 Equilibrium

The equilibrium in the economy is defined as the stream of consumption $\{c_1(t)\}_0^\infty$, physical capital, $\{k(t)\}_0^\infty$, prices, $\{r(t), w(t)\}_0^\infty$, capital allocation, $\{k_1(t), k_2(t)\}_0^\infty$, the evasion rate, $\{e(t)\}_0^\infty$, the tax rate, $\tau(t)$, the enforcement effort of the government, $\{\pi(t), \theta(t)\}_0^\infty$, the corruption incidences, $\{\pi_1(t), \pi_2(t)\}_0^\infty$ and the bribe rates, $\{b_1(t), b_2(t)\}_0^\infty$, such that they satisfy the optimality conditions obtained for household's, firm's and government's problems, and market clearance, as described above.

3 Equilibrium Analysis

3.1 The Effects of Corruption on the Evasion Rate

By considering the effects of different corruption-related measures, one can state the following lemma.

Lemma 1:

- (i) *An increase in the expected returns to tax evasion, μ_1 , raises tax evasion, whereas, an increase in the uncertainty associated with it, reduces tax evasion. That is, $\frac{\partial e^*}{\partial \mu_1} > 0$ and $\frac{\partial e^*}{\partial \sigma_1} < 0$ holds.*
- (ii) *An increase in the expected returns to bureaucratic extortion, μ_2 , and in the uncertainty associated with it, increases tax evasion. That is, $\frac{\partial e^*}{\partial \mu_2} > 0$ and $\frac{\partial e^*}{\partial \sigma_2} > 0$ holds.*
- (iii) *An increase in the cost of evasion, η , reduces the evasion rate. That is, $\frac{\partial e^*}{\partial \eta} < 0$ holds.*

Proof: This is straightforward from the comparative statics of eq. [33] with respect to μ_1 , σ_1 , μ_2 , σ_2 and η , correspondingly. ■

These results can be interpreted as follows. An increase in the return to a stochastic income-generating process such as tax evasion makes it more attractive, hence, evasion rises. On the other hand, an increase in the risk (uncertainty) associated with tax evasion leads to a reduction in this activity. In the case of coercive corruption, an increase in both the burden and uncertainty induces the taxpayer to engage in more evasion to compensate for the loss of disposable income. Lastly, raising tax evasion costs reduces evasion, as it is intuitively expected.

The findings of Lemma 1 can be related to the changes in the incident and the burden of corruption. For that purpose, one can combine Proposition 2 and Lemma 1 and state the following corollary.

Corollary 2: *The tax evasion rate, e , falls with the bribe rate, b_1 , but increases with the incidence of collusive corruption, π_1 . That is, $\frac{\partial e^*}{\partial b_1} < 0$ and $\frac{\partial e^*}{\partial \pi_1} > 0$ hold.*

Proof: It can be verified that $\frac{\partial e^*}{\partial b_1} = \frac{\partial e^*}{\partial \mu_1} \frac{\partial \mu_1}{\partial b_1} + \frac{\partial e^*}{\partial \sigma_1} \frac{\partial \sigma_1}{\partial b_1} < 0$ as $\frac{\partial e^*}{\partial \mu_1} > 0$, $\frac{\partial e^*}{\partial \sigma_1} < 0$, from Lemma 1 and $\frac{\partial \mu_1}{\partial b_1} < 0$, $\frac{\partial \sigma_1}{\partial b_1} > 0$ from Proposition 1. Analogously, one can verify that $\frac{\partial e^*}{\partial \pi_1} = \frac{\partial e^*}{\partial \mu_1} \frac{\partial \mu_1}{\partial \pi_1} + \frac{\partial e^*}{\partial \sigma_1} \frac{\partial \sigma_1}{\partial \pi_1} > 0$, due to $\frac{\partial e^*}{\partial \mu_1} > 0$, $\frac{\partial e^*}{\partial \sigma_1} < 0$ from Lemma 1 and $\frac{\partial \mu_1}{\partial \pi_1} > 0$, $\frac{\partial \sigma_1}{\partial \pi_1} < 0$, from Proposition 2. ■

From the above results one can see that an increase in the bribe rate results in a decline of tax evasion as a response to higher uncertainty and lower returns. An increase in the incidence of collusive corruption leads to more tax evasion as it raises the returns to evasion while reducing the uncertainty (risk) associated with it.

Analogously, by analysing the effects of the bribe rate and the incidence of coercive corruption on the rate of tax evasion, the following corollary is stated.

Corollary 3: *The tax evasion rate, e , rises with the bribe rate, b_2 , whereas the effect of the incidence of collusive corruption on tax evasion is ambiguous. That is, $\frac{\partial e^*}{\partial b_2} > 0$, and $\frac{\partial e^*}{\partial \pi_2} \leq 0$ hold.*

Proof: It can be verified that $\frac{\partial e^*}{\partial b_2} = \frac{\partial e^*}{\partial \mu_2} \frac{\partial \mu_2}{\partial b_2} + \frac{\partial e^*}{\partial \sigma_2} \frac{\partial \sigma_2}{\partial b_2} > 0$ as $\frac{\partial e^*}{\partial \mu_2} > 0$, $\frac{\partial e^*}{\partial \sigma_2} > 0$, from Lemma 1 and $\frac{\partial \mu_2}{\partial b_2} > 0$, $\frac{\partial \sigma_2}{\partial b_2} > 0$ from Proposition 1. Analogously, one can verify that $\frac{\partial e^*}{\partial \pi_2} = \frac{\partial e^*}{\partial \mu_2} \frac{\partial \mu_2}{\partial \pi_2} + \frac{\partial e^*}{\partial \sigma_2} \frac{\partial \sigma_2}{\partial \pi_2} \leq 0$, due to $\frac{\partial e^*}{\partial \mu_2} > 0$, $\frac{\partial e^*}{\partial \sigma_2} > 0$, from Lemma 1 and $\frac{\partial \mu_2}{\partial \pi_2} > 0$, $\frac{\partial \sigma_2}{\partial \pi_2} \leq 0$ from Proposition 2. ■

This result indicates that a private agent tries to compensate for the losses stemming from the higher burden of coercive corruption, by hiding a larger fraction of his/her income from taxation. Although in general the effect of an increase in the incidence of coercive corruption evasion is ambiguous, still, as soon as this change results in higher uncertainty, it leads to higher tax evasion.

3.2 The Effects of Corruption on the Capital Allocation

The equilibrium expressions for the capital share in the high-productivity sector eq. [35] can be used to conduct comparative statics analysis. Taking the first-

order derivatives of the expression for the capital in the high-productivity sector, k_2^* with regard to the measures of both types of corruption (the mean value of extorted income μ_2) and the measure of uncertainty, σ_2 , the following lemma is formulated.

Lemma 2: *An increase in the burden of coercive corruption and the uncertainty caused by it decreases the share of capital in the high-productivity sector. An increase in the rate of return to evasion and the uncertainty stemming from it, does not have any direct effect on the share of capital in the high-productivity sector.*

Proof: Using eq. [35], one can verify that the following results hold:

$$\begin{aligned}\frac{\partial n}{\partial \mu_2} &< 0, \quad \frac{\partial n}{\partial \sigma_2} < 0. \\ \frac{\partial n}{\partial \mu_1} &= 0, \quad \frac{\partial n}{\partial \sigma_1} = 0. \blacksquare\end{aligned}$$

Intuitively, an increase in both the expected burden of coercive corruption and the uncertainty stemming from it should discourage investment in the high-productivity sector. These results imply that both the direct burden imposed by corruption and the income uncertainty induced by it are important factors driving the effects of corruption on economic growth. Furthermore, from Proposition 1 it is known that an increase in the burden of corruption also leads to higher levels of income uncertainty, which suggests that corruption-induced income uncertainty aggravates the impact of corruption on the economy. Combining Lemma 2 with Proposition 2, the following corollary is stated.

Corollary 4: *The share of capital employed in the high-productivity sector, n , decreases with a higher bribe rate in coercive corruption, whereas the effect of an increase in the probability of coercive corruption is ambiguous.*

Proof: One can ascertain that $\frac{\partial n}{\partial b_2} = \frac{\partial n}{\partial \mu_2} \frac{\partial \mu_2}{\partial b_2} + \frac{\partial n}{\partial \sigma_2} \frac{\partial \sigma_2}{\partial b_2} < 0$, as $\frac{\partial n}{\partial \mu_2} < 0$, $\frac{\partial n}{\partial \sigma_2} < 0$, from Lemma 2 and that $\frac{\partial \mu_2}{\partial b_2} < 0$, $\frac{\partial \sigma_2}{\partial b_2} > 0$, from Proposition 1. Similarly, $\frac{\partial n}{\partial \pi_2} = \frac{\partial n}{\partial \mu_2} \frac{\partial \mu_2}{\partial \pi_2} + \frac{\partial n}{\partial \sigma_2} \frac{\partial \sigma_2}{\partial \pi_2} \leq 0$ due to $\frac{\partial n}{\partial \mu_2} < 0$, $\frac{\partial n}{\partial \sigma_2} < 0$ from Lemma 2 and $\frac{\partial \mu_2}{\partial \pi_2} < 0$, $\frac{\partial \sigma_2}{\partial \pi_2} < 0$, if $\pi_2 > 1/2$, and positive otherwise, from Proposition 2. Therefore, $\frac{\partial n}{\partial \pi_2} > 0$ if $\pi_2 > 1/2$, and $\frac{\partial n}{\partial \pi_2} < 0$ otherwise. $\blacksquare$

The effect of a higher bribe rate on coercive corruption is quite intuitive. A higher bribe payment makes the investment in the high-productivity sector less profitable and more risky. However, the effect of an increase in the incidence of such corruption on capital allocation depends on whether this effect is

accompanied by a higher or lower income uncertainty. As the results indicate, when the incidence of coercive corruption is relatively high, increasing it further reduces the uncertainty of investment in the high-productivity sector, and hence, the share of capital in this sector rises. In other words, Corollary 4 implies that the positive relationship between the probability of coercive corruption and economic performance is contingent on the incidence of corruption.

In relation with the result stated in Corollary 4, it is worth to note that Dreher and Gassebner (2013) find that corruption can help firm entry by reducing the burden of regulations. Are the results found in this study in line with their finding? In the context of Corollary 4 and Proposition 2, if the measure of corruption used in their estimations reflects the incidence of corruption rather than its burden through bribes, then the above results indicate that after reaching some threshold levels, corruption can facilitate firm entry by reducing the income uncertainty faced by firms. However, it needs to be established empirically, the existence of a non-linear relationship between the incidence of coercive corruption and income uncertainty, and evaluated whether these non-linear effects of corruption have implications on market entry and growth of firms. On the other hand, there is some empirical evidence that supports the negative relationship between a higher burden of bribes and firm entry, established in Corollary 4. Kaufmann and Wei (1999) based on firm-level data report that more spending on bribes, in fact, leads to more time being wasted in dealing with bureaucrats. Fisman and Svensson (2007) analysed a survey of Ugandan firms and find that with an increase in bribe rates the growth of firms declines.

3.3 Growth Effects of Corruption

In analysing the growth effects of corruption, the feedback effect from government services to productivity needs to be accounted for, as corruption through its impact on tax evasion and capital allocation, indirectly affects government inputs into private production. In particular, the expression for φ can be reformulated as follows by substituting for $g = \nu(1 - e) \tau y_2$ from eq. [6]:

$$\varphi = g^\delta = kn(\nu(1 - e)\tau A)^{\frac{\delta}{1-\delta}}.$$

By analysing the comparative statics of this expression with respect to the capital share and the tax rate of tax evasion, the following lemma is stated.

Lemma 3: *The productive externality provided by the public sector is increasing in the size of the capital employed in the high-productivity sector and decreasing in the tax evasion rate.*

Proof: Recall that $\varphi = kn(v(1-e)\tau A)^{\frac{\delta}{1-\delta}}$. Thus, it is straightforward to show that $\frac{\partial \varphi}{\partial n} > 0$, and $\frac{\partial \varphi}{\partial e} < 0$. ■

The next step is to analyse the growth effects of changes in the share of capital invested in the high-productivity sector and the rate of tax evasion. It is clear that a decline in the size of the high-productivity sector should decrease the growth rate of the economy, as the overall productivity falls with it. Also, tax evasion leads to less government revenue, which in turn leads to a reduction of the productive externality provided by government spending. This result is stated as the following proposition.

Proposition 3: *A decrease in the amount of capital employed in the high-productivity sector unambiguously reduces the growth rate of the economy.*

Proof: By taking the derivative of eq. [37] with respect to n , the following is obtained:

$$\frac{\partial \gamma}{\partial n} = \left(A\varphi + An \frac{\partial \varphi}{\partial n} \right) [1 - \tau - \mu_2 + \mu_1 \tau e - \eta e] - B.$$

From Lemma 3 $\frac{\partial \varphi}{\partial n} > 0$, thus, $\frac{\partial \gamma}{\partial n} > 0$. ■

This result is not surprising: the smaller the size of the high-productivity sector, the lower is the overall productive capacity of the economy, and hence, the growth rate.

Analogously, one can consider the effect of tax evasion on the growth rate.

Proposition 4: *An increase in the tax evasion rate has an ambiguous effect on the growth rate of the economy.*

Proof: By taking the derivative of eq. [37] with respect to e , we obtain the following:

$$\frac{\partial \gamma}{\partial e} = An \left(\varphi (\mu_1 \tau - \eta) + \frac{\partial \varphi}{\partial e} \right).$$

From Lemma 3 $\frac{\partial \varphi}{\partial e} < 0$, thus, $\frac{\partial \gamma}{\partial e} \leq 0$. ■

In this case, the ambiguity stems from the existence of the two counteracting effects: the income and productivity effect. Certainly, an increase in tax evasion raises disposable income, therefore, increasing capital accumulation and growth.

However, a reduction in public spending, due to lower tax revenue, decreases the productivity of firms. Therefore, in an environment with a non-efficient government, an increase in tax evasion induced by corruption can prove growth-enhancing; hence, supporting the “grease-on-wheels” literature. On the other hand, if the government was functioning at its optimal level, then an increase in tax evasion would lead to a contraction of growth.

3.3.1 Growth Effects of Changes in Bribe Rates and the Probability of Corruption

Both the incidence and the burden engendered by corruption can indicate the extent of corruption. Therefore, here we consider how changes in the probability of corruption and the bribe rates affect economic growth. To implement this, the following comparative statics for $\frac{\partial y}{\partial \pi_1}$, $\frac{\partial y}{\partial \pi_2}$, $\frac{\partial y}{\partial b_1}$, $\frac{\partial y}{\partial b_2}$ are analysed.

First, the collusive corruption case is considered, which yields the following proposition.

Proposition 5: *An increase in the probability and the bribe rate of collusive corruption affects growth through the income and productivity channels. These effects work in opposite directions. The overall growth effect of an increase in the probability and the bribe rate of collusive corruption depends on whether the income effect or the productivity effect dominates. Evidently, in an environment with weak public institutions, the productivity effect may be smaller than the income effect; thus, it may create conditions for greater collusive corruption.*

Proof: By taking the derivative of the growth rate, given by eq. [37], with respect to the probability, π_1 of collusive corruption, one obtains the following:

$$\frac{\partial y}{\partial \pi_1} = \underbrace{An\varphi \left((\mu_1\tau - \eta) \overbrace{\frac{\partial e}{\partial \pi_1}}^{(+)} + \tau e \overbrace{\frac{\partial \mu_1}{\partial \pi_1}}^{(+)} \right)}_{\text{income effect}} + \underbrace{An \left(\overbrace{\frac{\partial \varphi}{\partial e}}^{(-)} \overbrace{\frac{\partial e}{\partial \pi_1}}^{(+)} \right)}_{\text{productivity effect}} [1 - \tau - \mu_2 + \mu_1\tau e - \eta e] \leq 0.$$

Recall from Lemma 3 that $\frac{\partial \varphi}{\partial e} < 0$, and from Corollary 2 that $\frac{\partial e}{\partial \pi_1} > 0$. This implies that a higher probability of collusive corruption has a negative effect on productivity as it increases tax evasion ($\frac{\partial e}{\partial \pi_1} > 0$). Based on Proposition 2 and

Corollary 1, $\frac{\partial \mu_1}{\partial \pi_1} > 0$, and given that $\frac{\partial e}{\partial \pi_1} > 0$, the overall income effect of an increase in the incidence of collusive corruption is positive. Since the signs of these two effects are opposite, the direction of the dominating effect determines the overall growth effect of an increase in the incidence of collusive corruption.

Furthermore, the derivative of the growth rate with respect to the bribe rate, b_1 , yields the following:

$$\frac{\partial y}{\partial b_1} = \underbrace{An\varphi \left(e\tau \overbrace{\frac{\partial \mu_1}{\partial b_1}}^{(-)} + (\mu_1\tau - \eta) \overbrace{\frac{\partial e}{\partial b_1}}^{(-)} \right)}_{\text{income effect}} + \underbrace{An[1 - \tau - \mu_2 + \mu_1\tau e - \eta e] \left(\overbrace{\frac{\partial \varphi}{\partial e}}^{(-)} \overbrace{\frac{\partial e}{\partial b_1}}^{(-)} \right)}_{\text{productivity effect}} \leq 0.$$

To understand this result, recall from Proposition 1 and Corollary 1 that $\frac{\partial \mu_1}{\partial b_1} < 0$, and Corollary 2 that $\frac{\partial e}{\partial b_1} < 0$. Also, recall from Lemma 3 that $\frac{\partial \varphi}{\partial b_1} < 0$. Therefore, the above comparative statics shows that an increase in the bribe rate of collusive corruption results in a negative income effect and a positive productivity effect. Hence, the overall growth effect of such a change is determined by the dominating effect. ■

This result can be interpreted as follows. If a higher incidence of collusive corruption facilitates tax evasion, then it certainly increases the after-tax income of the private agent, and hence, his/her capital accumulation. However, less revenue collected due to increased tax evasion also implies a marginally lower productive externality being provided by the public sector, which hampers overall productivity, reduces returns to capital and creates disincentives for capital accumulation. On the other hand, an increase in the burden of collusive corruption reduces incomes of private agents but increases productivity by raising government revenue and spending. Thus, the overall effect of an increase in the incidence or the burden of collusive bribery depends on whether the income effect or the productivity effect dominates.

Next, a similar analysis with respect to coercive corruption is considered and the following proposition is stated.

Proposition 6: *An increase in the bribe rate of coercive corruption unambiguously deteriorates growth. An increase in the probability of coercive corruption has an ambiguous impact on growth.*

Proof: It is straightforward to obtain the following:

[38]

$$\begin{aligned} \frac{\partial \gamma}{\partial b_2} = & \underbrace{-A\varphi n \left(\overbrace{\frac{\partial \mu_2}{\partial b_2}}^{(+)} - (\mu_1 \tau - \eta) \overbrace{\frac{\partial e}{\partial b_2}}^{(+)} \right)}_{\text{income effect}} + \\ & \underbrace{+ [1 - \tau - \mu_2 + \mu_1 \tau e - \eta e] A \left(n \overbrace{\frac{\partial \varphi}{\partial n}}^{(+)} \overbrace{\frac{\partial n}{\partial b_2}}^{(-)} + \varphi \overbrace{\frac{\partial n}{\partial b_2}}^{(-)} + \overbrace{\frac{\partial \varphi}{\partial e}}^{(-)} \overbrace{\frac{\partial e}{\partial b_2}}^{(+)} \right)}_{\text{productivity effect}} < 0. \end{aligned}$$

Recall from Proposition 1 that $\frac{\partial \mu_2}{\partial b_2} > 0$ and $\frac{\partial e}{\partial b_2} > 0$ from Corollary 3; from Lemma 3 that $\frac{\partial \varphi}{\partial n} > 0$ and $\frac{\partial \varphi}{\partial e} < 0$, and from Corollary 4, $\frac{\partial n}{\partial b_2} < 0$. Therefore, $\frac{\partial \gamma}{\partial b_2} < 0$.

Analogously, the growth effect of an increase in the incidence of coercive corruption is presented as follows:

$$\begin{aligned} \frac{\partial \gamma}{\partial \pi_2} = & \underbrace{-A\varphi n \left(\overbrace{\frac{\partial \mu_2}{\partial \pi_2}}^{(+)} - (\mu_1 \tau - \eta) \overbrace{\frac{\partial e}{\partial \pi_2}}^{(\pm)} \right)}_{\text{income effect}} + \\ & \underbrace{+ [1 - \tau - \mu_2 + \mu_1 \tau e - \eta e] A \left(n \overbrace{\frac{\partial \varphi}{\partial n}}^{(+)} \overbrace{\frac{\partial n}{\partial \pi_2}}^{(\pm)} + \varphi \overbrace{\frac{\partial n}{\partial \pi_2}}^{(\pm)} + \overbrace{\frac{\partial \varphi}{\partial e}}^{(-)} \overbrace{\frac{\partial e}{\partial \pi_2}}^{(\pm)} \right)}_{\text{productivity effect}} \leq 0. \end{aligned} \quad [39]$$

According to Proposition 2 $\frac{\partial \mu_2}{\partial \pi_2} > 0$, and Lemma 3, $\frac{\partial \varphi}{\partial n} > 0$ and $\frac{\partial \varphi}{\partial e} < 0$. From Corollary 4 and Corollary 3, $\frac{\partial n}{\partial \pi_2} > 0$ and $\frac{\partial n}{\partial \pi_2} < 0$ if $\pi_2 > 1/2$, and $\frac{\partial n}{\partial \pi_2} < 0$ and $\frac{\partial e}{\partial \pi_2} > 0$ otherwise. Therefore, in general, $\frac{\partial \gamma}{\partial \pi_2}$ has an ambiguous sign. ■

One can explain these findings as follows. An increase in the bribe rate of coercive corruption directly decreases returns to capital, and hence, the growth rate falls. The growth effect of an increase in the probability of coercive corruption depends on whether this change leads to a fall or rise of income uncertainty

associated with this corruption. Clearly, when such an increase in the incidence of coercive corruption results in lower uncertainty, the outcome for growth is positive. Therefore, this result refines the findings by Blackburn and Forgues-Puccio (2009), Blackburn and Wang (2009) and Shleifer and Vishny (1993) by demonstrating that only in environments where corruption is widespread, more organized corruption does create positive effects, due to the reduced uncertainty.

4 A Discussion of the Results and Concluding Remarks

The model developed in this paper yields several insights into the relationship between corruption and economic growth. The key point of the results obtained in this study is that the adverse effect of corruption on economic growth stems not only from its burden (income and productivity effects) on private agents, but also from the corruption-induced income uncertainty. Therefore, ignoring the income uncertainty that results from corruption would result in a failure to capture the full effect of corruption on the economy.

An important insight established in this paper is that both the expected burden of corruption and the uncertainty stemming from bribery, impact on the income of the agents not only directly, but also indirectly by distorting the public productivity externalities. For instance, an increase in the incidence of collusive corruption creates a positive income effect, although a greater flight to the shadow economy contributes to a decline in the positive public externalities through the reduction of tax revenue. Interestingly, an increase in the burden of collusive corruption can have growth-enhancing effects if the reduction in the shadow economy and the rise in the tax revenue is large enough to offset the negative income effect of the increased bribes. Only in the case of coercive corruption, the increase in burden caused by higher bribes leads to unambiguous deterioration in growth, through the reduction of private income, and indirectly, by creating disincentives to capital allocation in the high-productivity sector. On the other hand, an increase in the incidence of coercive corruption may enhance growth in highly corrupt environments, by reducing income uncertainty. However, it will hamper growth if the initial incidence of coercive corruption is relatively low, as this type of change results in both a higher income burden and increased uncertainty imposed onto the private agents.

The result obtained in this study suggests that in high-incidence environments, at least a part of the non-linearity is likely to be due to a decrease in

income uncertainty. Moreover, by showing that the income uncertainty induced by coercive corruption depends on the threshold level of incidence, the above result offers additional support to the proposition that relates the effect of corruption to its frequency. This proposition states that with a rise in the number of corrupt bureaucrats, the probability of detection of an individual bureaucrat decreases, thereby creating a stronger incentive for corruption (e. g. Andvig and Moene 1990; Blackburn, Bose, and Haque 2006; Cadot, 1987; Çulea and Fulton 2009; Haque and Kneller 2009). In other words, widespread corruption generates an externality of corruption culture, not only by reducing the cost of corrupt behaviour, but also by decreasing the income uncertainty faced by the private agents.¹²

The results obtained in the paper have some empirical implications. In particular, the nonlinear relationship between coercive corruption and uncertainty suggests that it might be the cause of the non-linearity of the growth effect of corruption (Swaleheen 2011). Furthermore, since in an environment with weak institutions, the uncertainty associated with corruption is expected to be higher. In light of this consideration, one can also link the non-linearity of uncertainty associated with corruption to the non-linear effects of corruption contingent on the quality of institutions found by Méndez and Sepúlveda (2006), Aidt, Dutta, and Sena (2008), Méon and Sekkat (2005) and Méon and Weill (2010). One can also relate the findings of this study to the empirical results by Dreher and Gassebner (2013), who find that corruption can help raise firm entry through its interaction with regulations. If the measure of corruption used in their estimations captures the incidence of corruption rather than its burden through bribes, then the above results indicate that after some threshold levels, corruption can ease firm entry by reducing the income uncertainty faced by firms. However, to be certain about this link, one needs to conduct empirical analysis to determine whether there is a non-linear relationship between the incidence of coercive corruption and income uncertainty. In addition, it may also be interesting to find out how this type of income uncertainty affects a market entry decision.

In addition, the aforementioned finding suggests a new mechanism that explains the cause of persistent coercive corruption. Specifically, Foellmi and Oechslin (2007) argue that coercive corruption persists because it redistributes

12 The important role of corruption culture and beliefs in the persistence of corruption is investigated by Kingston (2007, 2008), Miller (2006), Mishra (2006) and Balafoutas (2011). Based on an experimental study, Barr and Serra (2010) find some supporting evidence that corruption may be a cultural trait, although a similar experimental study by Cameron et al. (2009) yields inconclusive results on the relationship between culture and observed corruption levels.

income not only from non-officials to officials, but also within the group of potential entrepreneurs, by limiting market entry. The above result indicates that coercive corruption is likely to persist when its incidence is high, as it lowers the income uncertainty of private agents, and thus, complements the positive externalities of the corruption culture enjoyed by the bureaucrats.

In conclusion, some limitations of this study need to be highlighted. First of all, in the model employed in this study, some generalizations and simplifications are made for the sake of tractability. This may have prevented the model from capturing all the effects of corruption discussed in the extant literature. In addition, the model in the current study abstracts from the institutional aspects of the public sector. Incorporating the relationship between corruption and the quality of institutions into the model may be an interesting extension. Another extension could be to consider whether the effect of corruption on growth depends on the composition of government expenditures. All of the above-mentioned extensions of the model should provide interesting avenues for further research and may uncover more useful insights.

Appendix

Derivation of the Variance

By observing the random outcomes given in eq. [9] one can conclude that the stochastic part of the income shocks can be stated as

$$x_1 = \begin{cases} \tau\epsilon y_2, & \text{w. p. } p_1 = (1 - \pi), \quad (\text{no audit}) \\ (1 - b)\tau\epsilon y_2, & \text{w. p. } p_2 = \pi\pi_1, \quad (\text{audit, corruption}) \\ (1 - \theta)\tau\epsilon y_2, & \text{w. p. } p_3 = \pi(1 - \pi_1), \quad (\text{audit, nocorruption}) \end{cases} \quad [40]$$

To relate the trinomial distribution representing the tax evasion with corruption to the normal distribution, the following two equations are used. First, let us denote, $1 - b \equiv \vartheta$, and use an arbitrary amount of evaded tax, $\Delta\zeta$, rather than the total evaded tax, $\tau\epsilon y_2$. Then using that $1 - \theta = s$ and $p_3 = 1 - p_1 - p_2$, the mean of the random return to amount $\Delta\zeta$ of evaded tax, x_1 , which for this trinomial distribution is equated to the mean of the approximating normal distribution as

$$E[x_1] = [p_1 + p_2\vartheta + p_3s]\Delta\zeta = [p_1(1 + s) + p_2(\vartheta + s) - s]\Delta\zeta = \mu\Delta t \quad [41]$$

$$\begin{aligned} \text{Var}[x_1] &= E[x_1^2] - (E[x_1])^2 = \left[p_1(1-s^2) + p_2(\vartheta^2 - s^2) + s^2 - (p_1(1+s) + p_2(\vartheta+s) - s)^2 \right] \Delta\zeta \\ &= \sigma_1^2 \Delta t \end{aligned} \quad [42]$$

Setting, $\Delta\zeta = \lambda\sigma_1\sqrt{\Delta t}$, and solving eqs [41] and [42] together with $\sum_{i=1}^3 p_i = 1$ yields the following expressions that relate the parameters of the trinomial distribution to the normal distribution:

$$p_1 = \frac{\mu^2 \Delta t + \sigma_1^3 \lambda \sqrt{\Delta t} - \sigma_1^2 \lambda^2 s \vartheta + \sigma_1 \lambda \mu s \sqrt{\Delta t} - \sigma_1 \lambda \mu \sqrt{\Delta t} \vartheta}{\sigma_1^2 \lambda^2 + \sigma_1^2 \lambda^2 s - \sigma_1^2 \lambda^2 \vartheta - \sigma_1^2 \lambda^2 s \vartheta}, \quad [43]$$

$$p_2 = \frac{\mu^2 \Delta t - \sigma_1^2 \lambda^2 s + \sigma_1^3 \lambda \sqrt{\Delta t} - \sigma_1 \lambda \mu \sqrt{\Delta t} + \sigma_1 \lambda \mu s \sqrt{\Delta t}}{\sigma_1^2 \lambda^2 \vartheta^2 - \sigma_1^2 \lambda^2 s - \sigma_1^2 \lambda^2 \vartheta + \sigma_1^2 \lambda^2 s \vartheta}, \quad [44]$$

$$p_2 = \frac{\sigma_1^2 \lambda^2 \vartheta + \Delta t \mu^2 + \sigma_1^3 \lambda \sqrt{\Delta t} - \sigma_1 \lambda \mu \sqrt{\Delta t} - \sigma_1 \lambda \mu \vartheta \sqrt{\Delta t}}{\sigma_1^2 \lambda^2 (s + \vartheta)(s + 1)}. \quad [45]$$

Acknowledgement: The author thanks the editor and two anonymous referees for thought-provoking and detailed suggestions.

References

- Abed, G. T., and S. Gupta. 2002. *Governance, Corruption, and Economic Performance*. Washington, DC: International Monetary Fund.
- Aidt, T. S. 2009. "Corruption, Institutions, and Economic Development." *Oxford Review of Economic Policy* 25 (2):271–91.
- Aidt, T. S., J. Dutta, and V. Sena. 2008. "Governance Regimes, Corruption and Growth: Theory and Evidence." *Journal of Comparative Economics* 36 (2):195–220.
- Andvig, J., and K. O. Moene. 1990. "How Corruption May Corrupt." *Journal of Economic Behavior and Organization* 13:63–76.
- Balafoutas, L. 2011. "Public Beliefs and Corruption in a Repeated Psychological Game." *Journal of Economic Behavior and Organization* 78:51–9.
- Barelli, P., and Sd. A. Pessoa. 2012. "A Model of Capital Accumulation and Rent Seeking." *Economic Inquiry* 50 (2):399–417.
- Barr, A., and D. Serra. 2010. "Corruption and Culture: An Experimental Analysis." *Journal of Public Economics* 94:862–9.
- Barreto, R. A. 2000. "Endogenous Corruption in a Neoclassical Growth Model." *European Economic Review* 44 (1):35–60.
- Barro, R. J. 1990. "Government Spending in a Simple Model of Endogenous Growth." *The Journal of Political Economy* 98 (5 Part 2):S103–25.

- Barro, R., and X. Sala-i Martin. 1992. "Public Finance in Models of Economic Growth." *Review of Economic Studies* 59:645–61.
- Bates, R. H. 1981. *States and Markets in Tropical Africa: The Political Bases of Agricultural Policy*. Berkeley, CA: University of California Press.
- Beekman, G., E. H. Bulteose, and E. E. M. Nillesen. 2013. "Corruption and Economic Activity: Micro Level Evidence from Rural Liberia." *European Journal of Political Economy* 30:70–9.
- Blackburn, K., N. Bose, and M. E. Haque. 2006. "The Incidence and Persistence of Corruption in Economic Development." *Journal of Economic Dynamics & Control* 30:2447–67.
- Blackburn, K., N. Bose, and M. E. Haque. 2010. "Public Expenditures, Bureaucratic Corruption and Economic Development." *Journal of Economic Studies* 37:4–25.
- Blackburn, K., and G. F. Forgues-Puccio. 2009. "Why Is Corruption Less Harmful in Some Countries than in Others?" *Journal of Economic Behavior and Organization* 72 (3):797–810.
- Blackburn, K., and Y. Wang. 2009. Uncertainty, Entrepreneurship and the Organisation of Corruption. Centre for Growth and Business Cycle Research Discussion Paper Series, Economics, The University of Manchester, UK. <http://www.socialsciences.manchester.ac.uk/cgbcrc/dpcgbcrc/dpcgbcrc133.pdf>.
- Broadman, H. G., and F. Recanatini. 2002. "Corruption and Policy: Back to the Roots." *Journal of Policy Reform* 5:37–49.
- Cadot, O. 1987. "Corruption as a Gamble." *Journal of Public Economics* 33:223–44.
- Cameron, L., A. Chaudhuri, N. Erkal, and L. Gangadharan. 2009. "Propensities to Engage in and Punish Corrupt Behavior: Experimental Evidence from Australia, India, Indonesia and Singapore." *Journal of Public Economics* 93 (7–9):843–51.
- Campos, J. E., D. Lien, and S. Pradhan. 1999. "The Impact of Corruption on Investment: Predictability Matters." *World Development* 27:1050–67.
- Chang, F. -R. 2004. *Stochastic Optimization in Continuous Time, Chapter 4*. Cambridge; New York: Cambridge University Press.
- Chen, B. L. 2003. "Tax Evasion in a Model of Endogenous Growth." *Review of Economic Dynamics* 6 (2):381–403.
- Chen, B. L. 2006. "Economic Growth with an Optimal Public Spending Composition." *Oxford Economic Papers* 58:123–36.
- Coppier, R., and E. Michetti. 2006. "Corruption vs Production. A Non-linear Relationship." *Economic Modelling* 23:622–37.
- Cowell, F. A. 1990. "Tax Sheltering and the Cost of Evasion." *Oxford Economic Papers* 42:231–43.
- Çulea, M., and M. Fulton. 2009. "Business Culture and Tax Evasion: Why Corruption and the Unofficial Economy Can Persist." *Journal of Economic Behavior & Organization* 72:811–22.
- Del Monte, A., and E. Papagni. 2001. "Public Expenditure, Corruption, and Economic Growth: The Case of Italy." *European Journal of Political Economy* 170:12–16.
- Delavallade, C. 2006. "Corruption and Distribution of Public Spending in Developing Countries." *Journal of Economics and Finance* 30 (2):222–39.
- Dixit, A. K., and R. S. Pindyck. 1994. *Investment Under Uncertainty*. Princeton: Princeton University Press.
- de Vaal, A., and W. Ebben. 2011. "Institutions and the Relationship between Corruption and Economic Growth." *Review of Development Economics* 15 (1):108–23.
- Djankov, S., R. La Porta, F. Lopez-De-Silanes, and A. Shleifer. 2002. "The Regulation of Entry." *Quarterly Journal of Economics* 117:1–37.
- Dreher, A., and M. Gassebner. 2013. "Greasing the Wheels of Entrepreneurship? The Impact of Regulations and Corruption on Firm Entry." *Public Choice* 155 (3):413–32.

- Dzhumashev, R. 2014a. "Corruption and Growth: The Role of Governance, Public Spending, and Economic Development." *Economic Modelling* 37:202–15.
- Dzhumashev, R. 2014b. "The Two-Way Relationship between Government Spending and Corruption and Its Effects on Economic Growth." *Contemporary Economic Policy* 32:403–19.
- Dzhumashev, R., and E. Gahramanov. 2010. "A Growth Model with Income Tax Evasion: Some Implications for Australia." *Economic Record* 86 (275):620–36.
- Dzhumashev, R., and E. Gahramanov. 2011. "Comment on "a Dynamic Portfolio Choice Model of Tax Evasion: Comparative Statics of Tax Rates and Its Implication for Economic Growth." *Journal of Economic Dynamics and Control* 35:253–6.
- Ehrlich, I., and F. T. Lui. 1999. "Bureaucratic Corruption and Endogenous Economic Growth." *The Journal of Political Economy* 107:S270–93.
- Evrensel, A. Y. 2010. "Corruption, Growth, and Growth Volatility." *International Review of Economics and Finance* 19 (3):501–14.
- Fisman, R., and R. Gatti. 2006. "Bargaining for Bribes: The Role of Institutions, Ch. 4." In *International Handbook on the Economics of Corruption*, edited by S. Rose-Ackerman, 127–39. Cheltenham: Edward Elgar.
- Fisman, R., and J. Svensson. 2007. "Are Corruption and Taxation Really Harmful to Growth? Firm Level Evidence." *Journal of Development Economics* 83 (1):63–75.
- Foellmi, R., and M. Oechslin. 2007. "Who Gains from Coercive Corruption?" *Journal of Development Economics* 82:95–119.
- Futagami, K., Y. Morita, and A. Shibata. 1993. "Dynamic Analysis of an Endogenous Growth Model with Public Capital." *Scandinavian Journal of Economics* 95:525–607.
- Goel, R. K., and R. Ram. 2013. "Economic Uncertainty and Corruption: Evidence from a Large Cross-Country Data Set." *Applied Economics* 45:3462–8.
- Haque, M. E., and R. Kneller. 2009. "Corruption Clubs: Endogenous Thresholds in Corruption and Development." *Economics of Governance* 10:345–73.
- Hessami, Z. 2014. "Political Corruption, Public Procurement, and Budget Composition: Theory and Evidence from OECD Countries." *European Journal of Political Economy* 34: 372–89.
- Hunt, J. 2004. "Trust and Bribery: The Role of the Quid Pro Quo and the Link with Crime." NBER Working Papers 10510.
- Hunt, J. 2007. "Bribery in Health Care in Peru and Uganda." NBER Working Paper 13034.
- Huntington, S. P. 1968. *Political Order in Changing Societies*. New Haven, CT: Yale University Press.
- Kamrad, B., and P. Ritchken. 1991. "Multinomial Approximating Models for Options With k State Variables." *Management Science* 37:1640–52.
- Kaufmann, D., and S. J. Wei. 1999. "Does Grease Money Speed Up the Wheels of Commerce?" NBER Working Paper No. 7093.
- Keefer, P., and S. Knack. 2002. "Rent-Seeking and Policy Distortions when Property Rights are Insecure." Number 2910. The World Bank.
- Kingston, C. 2007. "Parochial Corruption." *Journal of Economic Behavior and Organization* 63:73–87.
- Kingston, C. 2008. "Social Structure and Cultures of Corruption." *Journal of Economic Behavior and Organization* 67:90–102.
- Kuncoro, A. 2006. "Corruption and Business Uncertainty in Indonesia." *ASEAN Economic Bulletin* 23 (1):11–30.

- Leff, N. 1964. "Economic Development through Bureaucratic Corruption." *American Behavioral Scientist* 8 (3):8–14.
- Levaggi, R., and F. Menoncin. 2012. "Tax Audits, Fines and Optimal Tax Evasion in a Dynamic Context." *Economics Letters* 117 (1):318–21.
- Levaggi, R., and F. Menoncin. 2013. "Optimal Dynamic Tax Evasion." *Journal of Economic Dynamics and Control* 37 (11):2157–67.
- Li, H., L. C. Xu, and H. Zou. 2000. "Corruption, Income Distribution and Growth." *Economics and Politics* 12:155–82.
- Lin, W.-Z., and C.-C. Yang. 2001. "A Dynamic Portfolio Choice Model of Tax Evasion: Comparative Statics of Tax Rates and Its Implication for Economic Growth." *Journal of Economic Dynamics and Control* 25:1827–40.
- Lui, F. T. 1985. "An Equilibrium Queuing Model of Bribery." *Journal of Political Economy* 93:760–81.
- Lui, F. T. 1996. "Three Aspects of Corruption." *Contemporary Economic Policy* 14 (3):26–9.
- Mauro, P. 1995. "Corruption and Growth." *Quarterly Journal of Economics* 110:681–712.
- Mauro, P. 1998. "Corruption and Composition of Government Expenditure." *Journal of Public Economics* 69:263–79.
- Mauro, P. 2004. "The Persistence of Corruption and Slow Economic Growth." *IMF Staff Papers* 51 (1):1–18.
- Miller, W. L. 2006. "Corruption and Corruptibility." *World Development* 34 (2):371–80.
- Mishra, A. 2006. "Persistence of Corruption: Some Theoretical Perspectives." *World Development* 34 (2):349–58.
- Mo, P. H. 2001. "Corruption and Economic Growth." *Journal of Comparative Economics* 29 (1):66–79.
- Mocan, N. 2008. "What Determines Corruption? International Evidence from Microdata." *Economic Inquiry* 46 (4):493–510.
- Murphy, K. M., A. Shleifer, and R. W. Vishny. 1993. "Why Is Rent-Seeking so Costly to Growth?" *American Economic Review Papers and Proceedings* 83 (2):409–14.
- Méndez, F., and F. Sepúlveda. 2006. "Corruption, Growth and Political Regimes: Cross Country Evidence." *European Journal of Political Economy* 22 (1):82–98.
- Méon, P. -G., and K. Sekkat. 2005. "Does Corruption Grease or Sand the Wheels of Growth?" *Public Choice* 122:69–97.
- Méon, P. -G., and L. Weill. 2010. "Is Corruption an Efficient Grease?" *World Development* 38 (3):244–59.
- Pellegrini, L., and R. Gerlagh. 2004. "Corruption's Effect on Growth and Its Transmission Channels." *KYKLOS* 57 (3):429–56.
- Polinsky, A. M., and S. Shavell. 2001. "Corruption and Optimal Law Enforcement." *Journal of Public Economics* 81:1–24.
- Rajkumar, A. S., and V. Swaroop. 2008. "Public Spending and Outcomes: Does Governance Matter?" *Journal of Development Economics* 86:96–111.
- Rock, M. T., and H. Bonnet. 2004. "The Comparative Politics of Corruption: Accounting for the East Asian Paradox in Empirical Studies of Corruption, Growth and Investment." *World Development* 32:999–1017.
- Ryvkin, D., and D. Serra. 2012. "How Corruptible Are You? Bribery Under Uncertainty." *Journal of Economic Behavior and Organization* 81:466–77.
- Sequiera, S., and S. Djankov. 2014. "Corruption and Firm Behaviour: Evidence from African Ports." *Journal of International Economics* 94 (2):277–94.

- Severini, T. A. 2005. *Elements of Distribution Theory*. New York, NY: Cambridge University Press.
- Shleifer, A., and R. W. Vishny. 1993. "Corruption." *The Quarterly Journal of Economics* 108 (3):599–617.
- Svensson, J. 2003. "Who Must Pay Bribes and How Much? Evidence from a Cross Section of Firms." *The Quarterly Journal of Economics* 118 (1):207–30.
- Svensson, J. 2005. "Eight Questions about Corruption." *Journal of Economic Perspectives* 19 (3):19–42.
- Swaleheen, M. 2011. "Economic Growth with Endogenous Corruption: An Empirical Study." *Public Choice* 146:23–41.
- Tanzi, V., and H. R. Davoodi. 2000. "Corruption, Growth, and Public Finances." IMF Working Paper, WP/00/182. Washington, DC: International Monetary Fund, Fiscal Affairs Department.
- Tsoukis, C., and N. J. Miller. 2003. "Public Services and Endogenous Growth." *Journal of Policy Modeling* 25:297–307.
- Turnovsky, S. J. 1996. "Fiscal Policy, Adjustment Costs and Endogenous Growth." *Oxford Economic Papers* 48:361–81.
- Wei, S.-J. 1997. "Why Is Corruption so Much Taxing than Tax? Arbitrariness Kills." Working Paper No. 6255. NBER, Cambridge, MA. <http://www.nber.org/papers/w6255>.
- Yitzhaki, S. 1974. "A Note on Income Tax Evasion: Theoretical Analysis." *Journal of Public Economics* 3 (2):201–2.