Corruption and Economic Growth Revisited
Draft

Maksym Ivanyna
Joint Vienna Institute

Alex Mourmouras
International Monetary Fund

Peter Rangazas
IUPUI

December 21, 2017

Abstract

While literature finds many channels through which corruption can hurt economic growth, the link proved hard to establish in empirical cross-country studies. In this paper we show that part of the explanation of this puzzle is that there is a reverse causality: everything else equal, exogenously-driven economic growth can increase corruption. The reason is that the boost to output increases tax revenue, and hence pool of resources that corrupt public officials can embezzle. We show the workings of this channel in a simple stylized model, which is then accompanied by numerical simulations in a dynamic general equilibium overlapping-generations model, which allows for corruption and tax evasion. We also present empirical evidence, which supports our findings.

Keywords: corruption, economic growth, corruption-growth nexus, overlapping generations model, tax evasion

JEL-classification: O11, D73, E32, O43, O47

1 Introduction

Social scientists came up with many channels of how corruption can hurt economic growth and efficiency.[1] Bribery is a secretive and highly uncertain payment to a bureaucrat, which increases cost of investment, erodes confidence, and distorts competition, while allowing dishonest businesses to avoid efficiency-enhancing government regulation. Embezzlement reduces efficiency of government spending, and hence undermines the fiscal sustainability, as well as government's ability to provide public goods.

Despite the large number of theoretical channels, many of which supported by micro-empirical evidence, at a macro level the negative link between corruption and growth has been hard to demonstrate. A seminal study on the topic, Mauro (1995), finds the relationship between corruption and growth to be unrobust.[2] Svensson (2005) replicates the Mauro's regressions at an updated sample, uses alternative estimation methods, but finds no significant results. He calls this finding "a puzzle". In a meta-study Ugur (2014) analyzes 29 peer-reviewed studies on the topic and concludes that corruption and per-capita GDP growth are negatively linked, but the relationship is weak and unrobust.

The literature offers several potential explanations for the weak link between corruption and growth. Svensson (2005) points to a measurement error, omitted variables in the growth regressions, and the fact that "corruption takes many forms, and there is no reason to believe that all types of corruption are equally harmful for growth" (p.39). Huntington (1968) and a number of subsequent studies argue that corruption can "grease the wheels of business", and hence actually improve growth in highly bureaucratic economies. However, to the extent that the inefficient bureaucracy is also likely a result of corruption, this argument is not likely to hold in general equilibrium setting. Ivanyna et al. (2016b) argue that in general equilibrium setting the effect of corruption on growth is negative but can be small in closed economies and when the government's borrowing is constrained. It is still unclear though why the empirical link between corruption and growth is weak across all countries.

This paper offers an alternative explanation of the weak empirical link be-

---

[1]See Olken and Pande (2012) for overview

[2]The relationship of corruption and investment is more robust. Also bureaucratic efficiency seems to perform better than corruption in the growth regressions

tween corruption and growth. Given the multitude of theoretical arguments,[3] it is highly likely that corruption has large negative effect on long-term potential economic growth. However, the empirical relationship between the two is contaminated by the reverse causality from economic growth to corruption in short and medium term. During economic booms tax revenue is higher and it is easier for government to borrow. This blows up the budgets that bureaucrats are in charge of, and consequently increases embezzlement and corruption. Hence what we empirically observe is the two offsetting effects: high-corruption countries growing slower on average over long-term, and at the same time higher corruption in countries that grow above potential in short and medium term. The two effects result in a weak empirical link between corruption and growth, especially when the relationship is tested over shorter time spans. Even for longer time spans the "growth-to-corruption" effect may still be present as long as corruption is driven by commodity price and financial cycles - both of much lower frequency than the business cycles.

We demonstrate our point using three approaches. First, we build a simple stylized model with corruption in an endowment economy. The goal is to provide a tractable framework to comprehend the workings of the "growth-to-corruption" effect. We show that higher endowments cause higher corruption. Second, we continue with much less tractable but much more comprehensive general equilibrium model, calibrated to an average developing economy. The model is a modified version of Ivanyna et al. (2016b). The price of being comprehensive is that we can only solve the model numerically. The numerical computations go in line with the simple model. Third, we put our findings to the data, and our results conform with the models.

2   Stylized model of corruption

The goal of the model in this section is to demonstrate the workings of the "growth-to-corruption" channel in a simplified tractable way. In the next section we show that the results of this simple model also carry through in a more comprehensive framework.

The model is significantly simplified version of Ivanyna et al. (2016b). It is static (one time period), and there is no production. There are two types of agents - private households and public officials. Each agent receives

---

[3]Especially taking into account the general equilibrium nature of corruption, which includes not only petty bribery but also policymaking at a grand level

an exogenous endowment. Private households consume the endowment plus transfers from government subject to income tax they are supposed to pay. They can also choose to evade part of the tax payment. Public officials redistribute the tax revenue, and may choose to embezzle part of it. Collectively, they also set the income tax rate.

2.1   Private households

There are N private households, each is exogenously endowed with income w. They pay tax τ on their endowment and consider evading part of the tax. They also receive transfer $\hat{g}$ from the government. Tax evasion is costly, part of the hidden income is lost when trying to conceal it. In addition, the households are averse to illegal activity, which is expressed in a loss of utility when there is tax evasion. The utility of the representative household is the following:

$$U = c - \frac{\phi}{2}v^2, \tag{1}$$

which they maximize subject to the budget constraint:

$$c = (1 - \tau)(1 - v)w + \theta^\tau vw + \hat{g}. \tag{2}$$

Here c is consumption, and v is tax evasion - a fraction of w that is concealed. The second part of U reflects the aversion to tax evasion, the "guilt". ϕ is the aversion parameter, the larger is ϕ the more there is disutility.

The total household income, the right hand side of (2), consists of three parts. First part is the after-tax income from endowment, which was not concealed. The second part is the income that was concealed and is available for private use - fraction v of w, adjusted by θ^τ. θ^τ represents government checks on tax evasion. It ranges between 0 (no concealed income is available for use at all) and 1 (no resource cost of hiding income). The more difficult it is to hide income from the government, the smaller is θ^τ, the less of it can be used, thus lowering the benefit of evasion. [4] The third part of the income is government transfer $\hat{g}$.

---

[4]In other words, θ^τ here is a pure waste or deadweight loss from having tax evasion

The first-order conditions imply that the optimal level of tax evasion is:[5]

$$v = \frac{(\theta^\tau - (1 - \tau))\, w}{\phi} \tag{3}$$

Everything else equal, tax evasion increases with weaker checks on evasion and higher τ. It also increases if private households are less averse to illegal activity (lower ϕ).

2.2 Public officials

There is fixed number ϵN of public officials in the economy. They are exogenously selected from the population of private sector households, and have preferences that are identical to the private households. Each public official is paid salary w^g, which is exogenously fixed, and takes charge of distributing government transfers to the private households. So the role of the government in this model is simply to collect income tax and redistribute it back to private households. This could be justified by concerns about income inequality and poverty. For simplicity, there is no production of public goods in this model.

Public officials set income tax rate τ collectively, while the redistribution is decentralized. Each public officials is allocated an equal share of tax revenue $G/\epsilon N$ after public salaries are paid. Part of the budget can be embezzled. As in case with the private households, embezzlement is costly, not all of it can be recovered for private use, and public officials are averse to illegal activity. The utility of the representative household is the following:

$$U^g = c^g - \frac{\phi}{2} u^2, \tag{4}$$

which they maximize subject to the budget constraint:

$$c^g = (1 - \tau)w^g + \theta^g u \frac{G}{\epsilon N}. \tag{5}$$

c^g is consumption, and u is the level of corruption - a fraction of the budget that is embezzled. The total income of a public official consists of after-tax salary and the embezzled funds, adjusted for θ^g. θ_g represent checks on

---

[5]For simplicity, here and below, assume that values of parameters are such that there are no corner solutions to the model

corruption. The lower it is the less of stolen funds are available for private use. It ranges from 0 (no stolen funds are available for use) to 1 (no checks, so no cost of embezzlement).

Individually, public officials take τ and G as given, and select optimal u. From the first-order conditions:

$$u = \frac{\theta^g}{\phi} \frac{G}{\epsilon N}. \tag{6}$$

Corruption increases with lower checks on corruption, lower aversion to illegal activity. Importantly, it also increases with the size of the budget that each public official gets. When ϵ is fixed, the size of individual budget depends on the total budget G. In this simple setting corruption is not related to the public salary w^g, but this depends on the functional specification of utility.[6]

2.3 Government budget constraint

Government collects income tax revenue and spends it on public salaries and transfers to the private households. The government budget constraint is the following:

$$G = (\tau(1 - v)w + \tau w^g \epsilon)\, N - w^g \epsilon N \tag{7}$$

The income tax revenue consists of tax paid by private households, that is after part of w is concealed, and tax paid by public officials.

The budget per public official is then:

$$g \equiv \frac{G}{\epsilon N} = \frac{\tau(1 - v)w}{\epsilon} - (1 - \tau)w^g. \tag{8}$$

Then the government transfer that is effectively received by a representative private household:

$$\hat{g} = \frac{(1 - u)G}{N} \tag{9}$$

The key question we attempt to answer in this model is if a positive shock to w increases u. Since u depends on G, the answer depends on whether increase in w increases G, which in turn depends on what happens with the tax paid by private households - $\tau(1 - v)w$. Taking into account (3):

$$R \equiv \tau(1 - v)w = \tau w - \tau \frac{\theta^\tau - (1 - \tau)}{\phi}w^2. \tag{10}$$

---

[6]In this model we hold w^g fixed, so relationship between u and w^g is less important. In the more comprehensive model this relationship is analyzed in more detail

The tax paid by the private households R is a quadratic function of w, with a negative quadratic term, so whether it increases or decreases with w depends on the government's choice of τ.

2.4   Choice of τ

Collectively public officials choose τ. They do it by maximizing the utility of a representative public official and taking into account the optimal responses of private households and public officials when it comes to the choice of v and u. The utility of a public official can be rewritten:

$$U^g = c^g - \frac{\phi}{2}u^2 = (1-\tau)w^g + \theta^g ug - \frac{\phi}{2}u^2 =$$

$$= (1-\tau)w^g + \frac{\theta^{g2}}{2\phi}g^2. \quad (11)$$

In choosing the tax rate public officials want to maximize the budget per public official g, which depends on τ directly and indirectly through v, and at the same time they weigh in the fact that they pay the tax as well. In addition, corruption increases the disposable income but brings in the disutility.

Differentiating (11) with respect to τ yields the first-order conditions:

$$-w^g + \frac{\theta^{g2}}{\phi}g\frac{\partial g}{\partial \tau} \Rightarrow \frac{\partial g}{\partial \tau} = \frac{w^g}{\theta^g u}, \quad (12)$$

where the last equality uses the first-order condition (6). In the optimum, public officials set the tax rate to the left of the peak of the Laffer curve - $\frac{\partial g}{\partial \tau} > 0$. The trade-off is between paying higher tax themselves and increasing the allocated budget per official g, and stealing part of it. This marginal benefit is $\theta^g u$ - smaller than one by construction.

2.5   Does corruption go up if private endowment increases?

What happens to corruption if private endowment w receives a positive shock? Such a shock would be a simulation of the "growth-to-corruption" effect - an exogenously driven economic growth, which affects the behavior of public officials.

From (6) it follows that corruption u changes in the same direction as g - the budget per official allocated for government transfers. So the key question is how an increase in w affects g.

In short run, when the tax rate τ is not yet changed and the tax evasion behavior, and hence v, remain the same, increased endowments means larger tax revenue means large budget for the transfers. Larger g means more opportunities for corruption, and hence more corruption.

In longer run, private households optimally respond to the shock by adjusting their tax evasion, and in principle g could end up lower than before. This will not happen however, because increased tax evasion will not offset the shock completely, and hence tax revenue will still increase.

To see this, let us first analyze medium run - a likely situation when tax evasion responds optimally, but the tax rate remains unchanged. The first step is to demonstrate that g is maximized when tax evasion $v = \frac{1}{2}$. With unchanged τ:

$$\frac{\partial g}{\partial w} = \tau \frac{1 - v}{\epsilon} - \frac{\tau w}{\epsilon} \frac{\partial v}{\partial w} =$$

$$= \tau \frac{1 - v}{\epsilon} - \tau \frac{v}{\epsilon} = \frac{\tau}{\epsilon}(1 - 2v) = 0 \iff v = \frac{1}{2}. \quad (13)$$

The consequence of (13) is that $\frac{\partial g}{\partial w} > 0$ if $v < \frac{1}{2}$.

The second step is to show that at the pre-shock optimum v is actually smaller than 0.5. Using (10) we can derive the tax rate that maximizes tax paid by private households:

$$\frac{\partial R}{\partial \tau} = w - \frac{\theta^\tau - 1}{\phi} w^2 - 2\tau \frac{w^2}{\phi} \Rightarrow$$

$$\Rightarrow \tau^{max} = \frac{1 - \frac{\theta^\tau - 1}{\phi} w}{2 \frac{w}{\phi}}. \quad (14)$$

Then the tax evasion when τ^{max} is charged:

$$v^{max} \quad = \quad \frac{\theta^\tau - (1 - \tau^{max})}{\phi} w \quad = \quad \frac{1}{2} + \frac{1}{2} \frac{\theta^\tau - 1}{\phi} w \quad < \quad \frac{1}{2}, \quad (15)$$

because $\theta^\tau < 1$ by definition.

8

The tax rate chosen by public officials in the optimum is even smaller than τ^{max}. Using (12):

$$\frac{\partial g}{\partial \tau} = \frac{1}{\epsilon}\frac{\partial R}{\partial \tau} + w^g = \frac{w^g}{\theta^g u} \;\Rightarrow$$

$$\Rightarrow \frac{1}{\epsilon}\frac{\partial R}{\partial \tau} = w^g(\frac{1}{\theta^g u} - 1) > 0 \quad (16)$$

At the optimal pre-shock τ tax paid by private households increases, which means that $\tau < \tau^{max}$. Therefore v is smaller that v^{max}, and so smaller than 0.5. Hence g will increase as a result of positive shock in w and so will corruption.

Corruption will still remain elevated in the longer run, when τ is also allowed to react to the shock. This is because in this case $\frac{\partial g}{\partial w} = \frac{\partial g}{\partial \tau}\frac{\partial \tau}{\partial w}$. From (12), $\frac{\partial g}{\partial \tau} > 0$, so the main question is what happens to the tax rate. τ should increase too, because, as shown above, with unchanged tax g goes up. Then from (12) $\frac{\partial g}{\partial \tau}$ goes down, which can only be the case if τ increases.

Intuitively, public officials always set tax rate so that the tax paid by the private households is to the left of the Laffer curve peak. Increase in taxable income increases tax evasion by the private households, but the tax paid nevertheless increases too. Increased evasion and taxable income induce public officials to raise the tax rate, but again the tax revenue remains increased. Hence, corruption goes up.

This stylized model is a basic demonstration of how exogenously driven economic growth can cause corruption to increase. The next step is to relax some of the assumptions, which we did to get the analytical solution, and see if the result still holds. The cost of making the model more comprehensive is that we are only able to get the numerical solutions with reasonably calibrated parameters.

3   Main model

Here we demonstrate that the "growth-to-corruption" effect takes place also in a dynamic general equilibrium setting with investment, production, and productivity-enhancing role of the government. The model we use is a gentle modification of Ivanyna et al. (2016b). We introduce two main differences. First, the aggregate productivity growth is now stochastic and receives shocks

every period. Second, we introduce sluggishness in the public wages - they are not as responsive to productivity shocks as private wages are.

The model is an overlapping-generations model of private capital accumulation. Similarly to the stylized model of the previous section, private households are allowed to evade taxes, public official are allowed to embezzle public funds. Both illegal activities are costly because resources are lost in attempting to conceal the actions. The stronger are the government's mechanisms for detection, the more resources are lost in avoiding detection. Households also experience a loss in utility, "'guilt"' from violating a social norm, when evading taxes or embezzling public funds. Furthermore the strength of the guilt associated with tax evasion varies inversely with the average level of corruption by government officials. In addition, the cultural effect extends to the government officials themselves - individual government officials are more likely to engage in corrupt behavior the higher is the level of corruption around them. See Ivanyna et al. (2016b) for justification of these assumptions.

3.1 Private choices

There are N young private households in each period, and fixed number ϵN of public officials. The households and public officials are standard two-period life-cycle savers. They work to earn wages (w_t), consume (c_{1t}), and save (s_t) in the first period to finance second period retirement-consumption (c_{2t+1}). Same with subscript g for the public officials. In addition to their own consumption, households also care about the general state of the economy - the average level of worker productivity during both periods of their lives (y_t, y_{t+1}). The last assumption is a form of altruism, which is introduced to allow for the possibility that households who become public officials have concerns about the current and future state of the economy and not only their private consumption.

The preferences of private households and public officials are written as

$$U_{y,t} = \ln c_{1t} + \beta \ln c_{2t+1} + \gamma(\ln y_t + \beta \ln y_{t+1}) - \frac{\phi}{2\bar{u}_t}v_t^2 \qquad (17)$$

and

$$U_{y,t}^g = \ln c_{1t}^g + \beta \ln c_{2t+1}^g + \gamma(\ln y_t + \beta \ln y_{t+1}) - \frac{\phi}{2\bar{u}_t}u_t^2, \qquad (18)$$

The illegal activity of private households is measured by v, the fraction of their income that is not reported for tax purposes. The illegal activity of public officials is measured by u, the fraction of the public investment budget that is diverted for private use. The last term in each expression captures the "'guilt"' or direct disutility of engaging in illegal activity.

Higher values of ϕ imply a stronger distaste for illegal activity. The disutility of illegal activity is also affected by the average level of corruption among government officials. The greater is the average level of corruption the less disutility an individual experiences from their own illegal activity. Ivanyna et al. (2016b) refers to this as the "'culture of corruption"' (COC) effect, and shows that it is essential element of the model if it is to replicate key features of the data on corruption.

The private household maximizes utility subject to the lifetime budget constraint

$$c_{1t} + \frac{c_{2t+1}}{(1 + r_{t+1})} = (1 - \tau_t)w_t(1 - v_t) + \theta^\tau w_t v_t, \tag{19}$$

where θ^τ is a parameter, that lies between zero and one, reflecting the fraction of unreported income that the household can recover for private use.

The maximization problem generates the following equation for tax evasion and private household saving

$$v_t = \frac{1}{2} \left(\sqrt{T^2 + \frac{4(1 + \beta)\bar{u}_t}{\phi}} - T \right), \tag{20}$$

where $T \equiv \frac{1 - \tau_t}{\theta^\tau - (1 - \tau_t)}$.

$$s_t = \frac{\beta}{1 + \beta} \left(1 - \tau_t + (\theta^\tau - 1 + \tau_t)v_t \right) w_t. \tag{21}$$

Evasion is increasing in τ_t and in θ^τ. Evasion is also increasing in $\bar{u}$. The term $(1 + \beta)/\phi$ is a measure of "'greed"' because it is a measure of the value of consumption relative to the disutility of being dishonest. Tax evasion is increasing in greed, other things constant.

Next, we move to the behavior of the public official. In the case of uncoordinated or decentralized corruption, each public official takes the average level of corruption, the tax rate, and the total public investment budget as given when making their private choices. The public official's private choices include what fraction of their project budget to divert for their own private

use. The budget allocated to each public official is $\hat{G}_{t+1}/\epsilon N$, where $\hat{G}_{t+1}$ is the amount of recorded or planned investment and not the actual investment.

The officials maximize utility subject to the public budget and their private lifetime budget constraint,

$$c_{1t}^g + \frac{c_{2t+1}^g}{(1 + r_{t+1})} = (1 - \tau_t)\eta w_t + \theta^g u_t \left(\frac{\hat{G}_{t+1}}{\epsilon N} \right), \tag{22}$$

where θ^g is a parameter, that lies between zero and one, reflecting the fraction of diverted public funds that the official can recover for private use.

The wage paid to public officials is proportional to the private sector wage, i.e. the public official's wage is ηw_t. η is one of the key variables in this model. It reflects two features. First is how are wages in private and public sectors related in the long-run. Second is how sluggish are public wages in the short run. In other words, how responsive they are to the temporary productivity shocks or changes in the private sector wages. η is defined in the following way:

$$\eta = \frac{\eta_1}{1 + \eta_2 \xi}, \tag{23}$$

where η_1 characterizes the long-term relation to the private sector wages, η_2 characterizes the sluggishness, and ξ is the size of a temporary shock or a temporary deviation of private sector wages from equilibrium.[7] If $\eta_1 = 1$ then public wages track private sector wages one-to-one in the long run (when $\xi = 0$). η_2 varies from 0 to 1. If $\eta_2 = 0$ then public wages perfectly track private sector wages also in the short run. If $\eta_2 = 1$ it means public wages do not react to temporary shocks at all. For example, suppose private sector wage receives a multiplicative temporary shock $1+\xi$. So in the current period the wage is $w(1 + \xi)$, where w is the long-run value. Then public wage is $\eta w(1 + \xi) = \eta_1 w \frac{1+\xi}{1+\eta_2\xi}$.

The maximization problem generates the following equations for corruption and the public official's private saving

$$u_t = \frac{1}{2} \left(\sqrt{\Gamma^2 + \frac{4(1 + \beta)\bar{u}_t}{\phi}} - \Gamma \right), \tag{24}$$

---

[7]ξ is discussed in the next subsection

where $\Gamma \equiv \frac{1 - \tau_t}{\theta^g \frac{\hat{G}_{t+1}/\epsilon N}{\eta w_t}}$.

$$s_t = \frac{\beta}{1 + \beta} \left((1 - \tau_t) + \theta^g u_t \frac{\hat{G}_{t+1}/\epsilon N}{\eta w_t} \right) \eta w_t. \tag{25}$$

As with evasion, corruption is increasing in τ_t and in θ^g . The larger is the budget that the official manages, relative to his official after-tax wage, the more tempting it is to be corrupt. This is also why corruption is decreasing in $\eta\epsilon$ - the larger is the official wage (increasing in η) relative to the official's budget (decreasing in the number of officials or ϵ), the lower is corruption. An increase in the official's wage raises consumption and lowers the value of additional consumption gained by diverting public funds. However, the larger is the size of the public budget, the greater is the benefit of diverting a higher fraction of it. In particular, if the budget increases faster than the wage corruption increases.

3.2 Firms

Production takes place within standard neoclassical firms that combine physical capital and human capital to produce output from a Cobb-Douglas technology

$$Y_t = K_t^\alpha (D_t N)^{1-\alpha}. \tag{26}$$

However, the productivity index (D) is a function of disembodied technology (A) and public capital per adult worker $(G/((1 + \epsilon)N))$ and is given by

$$D_t = A_t^{1-\mu}(G_t/(1 + \epsilon)N)^\mu, \tag{27}$$

where $0 < \mu < 1$ is a constant parameter. This specification captures the idea that public infrastructure raises the productivity of the private sector.

Disembodied technology A progresses at an exogenous rate d every period on average. In addition the growth rate of productivity is subject to a random temporary shock ξ with mean zero. So the overall growth of A every period is $d + \xi$. ξ here reflects all temporary factors that can affect the output. This includes both supply and demand shocks - business cycle developments, as well as developments over financial and asset price cycles, which have lower frequency.

Firms operate in perfectly competitive factor and output markets. This implies the profit-maximizing factor mix must satisfy

$$\delta + r_t = \alpha g_t^{\mu(1-\alpha)} k_t^{\alpha-1}, \tag{28}$$

$$w_t = (1 - \alpha) A_t g_t^{\mu(1-\alpha)} k_t^{\alpha}, \tag{29}$$

where δ is the rate of depreciation on physical capital, which we take to be one for simplicity, $g \equiv G_t / A(1 + \epsilon)N$, and $k \equiv K/AN$.

3.3 Capital market equilibrium and government budget constraint

The capital stock rented to firms in period t must be accumulated as retirement savings by the private households and government officials,

$$K_{t+1} = N s_t + \epsilon N s_t^g. \tag{30}$$

The government budget constraint is:

$$\tau_t(w_t(1 - v_t)N + \epsilon \eta w_t N) = \eta w_t \epsilon N + \hat{G}_{t+1}, \tag{31}$$

which implies that $\hat{G}_{t+1}/w_t \epsilon N = \tau_t \left(\frac{1-v_t}{\epsilon} + \eta \right) - \eta$.

The actual investment in public capital is the accounting measure $\hat{G}_{t+1}$ minus the budget funds consumed by the government officials. Subtracting the portion of the capital budget that is consumed by government officials from (31), and de-trending by dividing by A_{t+1}, gives us the transition equation for public capital intensity in the presence of corruption and evasion,

$$g_{t+1} = (1 - u_t)(\tau_t(1 - v_t + \epsilon \eta) - \eta \epsilon) \frac{(1 - \alpha) g_t^{\mu(1-\alpha)} k_t^{\alpha}}{(1 + d + \xi)(1 + \epsilon)}. \tag{32}$$

For a given tax rate, corruption and evasion both serve to shift the transition equation for public capital downward.

The private saving functions for private households and public officials, and (30) can be used to derive the transition equation for private capital,

$$k_{t+1} = \frac{\beta}{1 + \beta} *$$

$$* \left[(1 - \tau_t + (\theta^\tau - 1 + \tau_t)v_t) + \eta \epsilon \left((1 - \tau_t) + \theta^g u_t \left(\tau_t \left(\frac{1 - v_t}{\eta \epsilon} + 1 \right) - 1 \right) \right) \right] *$$

$$* \frac{(1 - \alpha) g_t^{\mu(1-\alpha)} k_t^{\alpha}}{1 + d + \xi}. \tag{33}$$

While corruption and evasion reduce funds available for public investment, for a given tax rate, they increase funds available for private investment. Thus, the overall effect of corruption and evasion on growth is not clear. In addition, the presence of corruption and evasion affects the tax rate chosen by the public officials.

3.4   Corruption, evasion, and the tax rate

Collectively public officials choose the tax rate, which maximizes the representative public official's welfare. The optimal tax rate takes in account tax rate effects on private choices, whether made by private households or public officials. This includes the effects of the tax rate on both corruption and evasion.

The representative government official's preferences for generation-t, including only those terms that are influenced by the choice of the current period tax rate:

$$
(1+\beta)\ln\left((1-\tau_t)+\theta^g u_t\left(\tau_t\left(\frac{1-v_t}{\eta\epsilon}+1\right)-1\right)\right)-\frac{\phi}{2}u_t+
$$
$$
+\beta\mu(1-\alpha)(1+\gamma)\ln\left((1-u_t)\left(\tau_t\left(\frac{1-v_t}{\eta\epsilon}+1\right)-1\right)\right)+\beta(\alpha(1+\gamma)-1)*
$$
$$
*\ln\left((1-\tau_t+(\theta^\tau-1+\tau_t)v_t)+\eta\epsilon\left((1-\tau_t)+\theta^g u_t\left(\tau_t\left(\frac{1-v_t}{\eta\epsilon}+1\right)-1\right)\right)\right).
$$
$$(34)$$

The first term determines the effect of tax rates and tax revenue on the private income and consumption of the government official. The second term is the disutility of being corrupt. The third term is the effect of taxation on public investment. Next period's public capital raises the welfare of a generation-t official because it (i) raises the marginal product of private capital and the rate of return to private capital and (ii) increases next period's worker productivity, which is valued by individuals in the economy under our assumptions. The last term is the effect of taxation on private investment. Private capital has two opposing effects on the public official's welfare. Next period's private capital stock lowers welfare because it lowers the rate of return to private capital, but also raises welfare because it increases next period's worker productivity.

It is not possible to derive an analytical expression for the optimal tax rate, and hence corruption and tax evasion. We calibrate the model and find

a numerical solution. The focus is on an average developing economy without much institutional checks on corruption and evasion. The key question that we ask is how aggregate productivity shock ξ affects corruption, everything else equal.

3.5 Calibrating the model

The model is calibrated to an average developing economy. We take values for most of the parameters from Ivanyna et al. (2016b). The output elasticities of private and public capital are conventional estimates: $\alpha = 0.33$, $\mu = 0.3$. Assuming that each period in the model lasts 20 years and the average annualized growth in labor productivity due to exogenous technological change is 2 percent we have $d = (1.02)^{20} - 1 = 0.4859$. We set share of public officials in the economy $\epsilon = 0.1429$, and we assume public wages track private sector wages one-to-one in the long-run - $\eta_1 = 1$. In the short-run we start with the assumption that public wages are fully sluggish, i.e. they do not respond to temporary shocks in private sectors wages - $\eta_2 = 1$. Values for parameters in the utility functions are also taken from Ivanyna et al. (2016b): $\beta = 0.198$ and $\gamma = 4.756$. Finally, we start with the assumption of no institutional checks on corruption or tax evasion: $\theta^\tau = \theta^g = 1$, and we calibrate ϕ to target the value of tax evasion v to $1/3$ ($\phi = 1.07$) The target is based on the summary of estimates for the relative size of the shadow economy reported by Porta and Shleifer (2008, Table I).

Under these values of parameters the steady state is the same as in Ivanyna et al. (2016b). What is left is to choose the size of aggregate productivity shocks ξ which hit the economy every period. The size of ξ depends on the length of period, which is assumed to be 20 years in the model. In general, the shorter is the period the larger is ξ, as temporary shocks would tend to offset each other over longer periods of time. For example, annual output gaps in developing economies can be as large as 10%, but over 20 years they would average almost to zero. At the same time, some asset price cycles can result in large ξ's even over longer periods of time. Ivanyna et al. (2016a) identify public debt cycles in upper middle income countries with an average amplitude of 17 percentage points of GDP, and an average length of 13 years. Commodity prices are also very volatile and persistent. For example, the price of oil was mostly around USD30-40 in the 90s, down from USD50-90 in 70s and 80s, and then went up to USD60-100 in the 2000s. This results in high volatility of output growth in resource-rich countries. We take

parsimonious approach in calibrating ξ, and solve the model under a wide range of possible outcomes. ξ varies from -0.95 to 2.4, which corresponds to the departure of the annual output growth from the potential (2%) of -5 percentage points to 5 percentage points (and 20 years in one period).

3.6 Simulations: Do aggregate productivity shocks increase corruption?

Based on the calibration above we do a number of simulations. We start with the baseline without shocks, which is identical to Ivanyna et al. (2016b). Then we hit the economy with aggregate productivity shock of different magnitude and see what happens to the equilibrium values of output, corruption, and tax evasion. The shocks vary from -0.95 to 2.4, and we initially assume public sector salary does not react to them ($\eta_2 = 1$).

Figure 1 shows the results. The first and main observation is that positive shocks generate both larger output and more corruption. The larger are the shocks the larger are the output and corruption as compared to the baseline with no shocks. A positive productivity shock increases the private sector wages and hence income tax revenue. Public sector salary does not adjust, which means that each public official gets a larger budget for public investment relative to her/his salary. Hence corruption increases. Because of the culture-of-corruption effect, tax evasion may also respond positively to the increased corruption. Public officials compensate for this by choosing a lower tax rate. As a result, when economy is hit by a positive aggregate productivity shock, we observe large increases in corruption and output, followed by a small or no increase in tax evasion.

Resulting from the productivity shocks, the positive correlation between output and corruption can explain why empirically the link between economic growth and corruption is very weak. From the one side, weak institutional checks on corruption lead to higher corruption and lower steady state output per worker. This is the relationship, which researchers are trying to estimate by using the growth regressions. From the other side, aggregate productivity shocks temporarily increase both corruption and output, which biases the regression coefficients. If shocks are persistent, the bias can be present even if the data is averaged over longer time spans. Figure 2 simulates the growth regressions from the model to demonstrate the points above. We take 100 observations ("countries"), which are identical to each other, i.e. all structu-
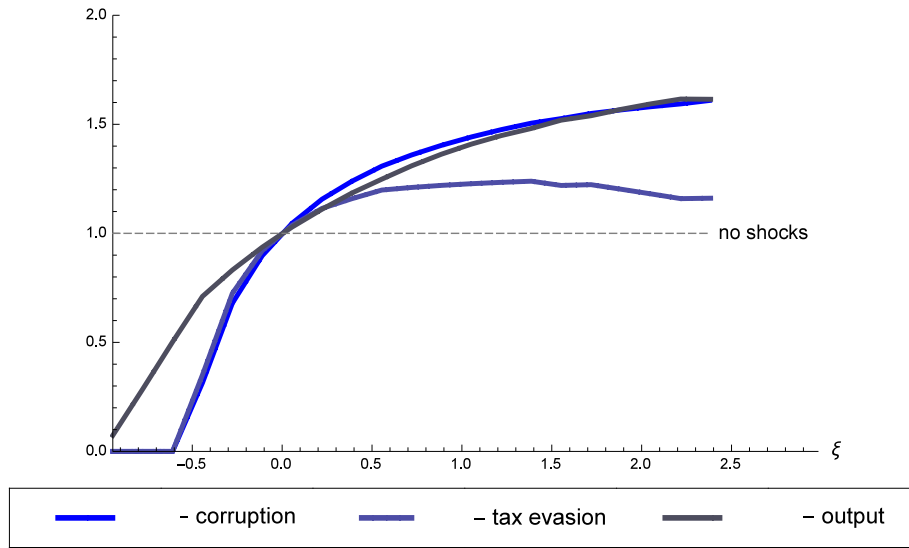
17

Figure 1: Aggregate productivity shocks: Response of corruption, tax evasion and output

Note Figure shows response of corruption, tax evasion and output for a range of aggregate productivity shocks ξ. All variables are expressed as ratio to the corresponding value in the baseline without shocks ($\xi = 0$). The computation is based on the following values for the model's parameters: $\theta^{gov} = 1$, $\theta^{\tau} = 1$, $\phi = 1.07$, $\eta_1 = 1$, $\eta_2 = 1$, $\epsilon = 0.14$, $\alpha = 0.33$, $\mu = 0.3$, $d = 0.49$, $\beta = 0.2$, $\gamma = 4.76$.

ral parameters are the same, except institutional checks on corruption θ^g and aggregate productivity shocks ξ that they face. θ^g is randomly drawn from uniform distribution $U(0.45, 1)$,[8] ξ is drawn from $U(-0.95, 2.4)$. ξ and θ^g are drawn independently. We run the model for each of the 100 observations, and find the equilibrium corruption and economic growth, which is defined as the growth of output relative to the baseline with no shocks and $\theta^g = 1$.[9] The right panel of Figure 2 shows the scatter plot of corruption and growth in case there are no shocks (or alternatively, if we manage to control for shocks in regressions). Here the pattern is as expected: lower corruption is associated with higher growth. The left panel shows the scatter plot when shocks are included. With shocks included, the relationship between corruption and growth turns inside out - now lower corruption is actually associated with lower growth. The "growth-to-corruption" effect dominates in this simulation. In reality the relationship between growth and corruption is usually not positive. Its sign and magnitude depend on the size of the shocks, the relationship between checks on corruption and steady-state output, and the sluggishness of public wages, which in this simulation is assumed to be full ($\eta_2 = 1$). But one thing is clear, the "growth-to-corruption" effect biases upwards the coefficient on corruption in growth regressions, and hence we likely underestimate the harm that corruption makes to the economy.

Another implication of the general model is that the "growth-to-corruption" effect is smaller if public officials' salary is more responsive to the productivity shocks. This is demonstrated by Figure 3. The figure shows the response of corruption to the shocks for different values of η_2. Lower values of this parameter mean the salary is more responsive. For each shock, corruption is closer to the baseline the lower is η_2. If public wages adjust quicker then budget-to-salary ratio does not increase as much, and so is corruption. At the same time, even if η_2 is low, the departure of corruption from the baseline can be significant. For example, $\eta_2 = 0.33$ means that 2/3 of the temporary shock is absorbed by the public wages. Still the corruption increase is generally more than half of the increase in case the wages do not adjust at all ($\eta_2 = 1$).

Though it is not directly in the model, one of its policy implications is that it might be a bad idea to use public wage bill as a tool for counter-cyclical

---

[8]The lower value of the support is chosen so that there is only small amount of countries with zero corruption

[9]So the growth rate in country with $\theta^g = 1$ and $\xi = 0$ is zero.
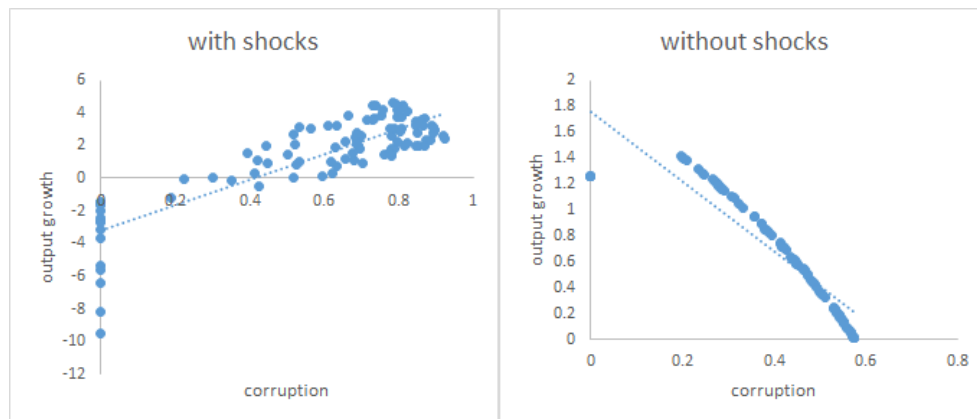
Figure 2: Growth regression simulations with and without shocks

Note Figure simulates from the model the growth regressions with corruption included as the independent variable. Sample of countries is formed using 100 independent draws from uniform $[0.45,1]$ distribution for θ_g and uniform $[-0.95,2.4]$ distribution for ξ. All other variables for all countries are left the same as in the baseline: $\theta^\tau = 1$, $\phi = 1.07$, $\eta_1 = 1$, $\eta_2 = 1$, $\epsilon = 0.14$, $\alpha = 0.33$, $\mu = 0.3$, $d = 0.49$, $\beta = 0.2$, $\gamma = 4.76$. Output growth is computed as the ratio to the corresponding value in the baseline without shocks ($\xi = 0$ and $\theta_g = 1$). Corruption is generated from the model. Left panel shows the scatter-plot and the fitted line for the "world" with both government checks on corruption and aggregate productivity shocks. Right panel shows the same for the "world" with no shocks.
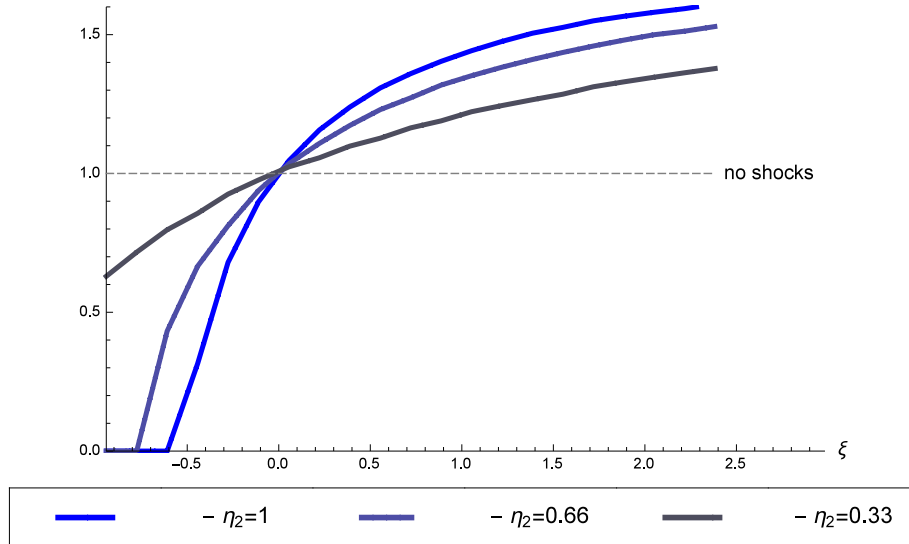
Figure 3: Corruption, shocks, and sluggishness of public officials' salaries

Note Figure shows response of corruption for a range of aggregate productivity shocks ξ and when responsiveness of public officials' salary to these shocks varies. $\eta_2 = 0$ means w^g fully responds to temporary shocks (no sluggishness), $\eta_2 = 1$ means w^g does not respond at all. All variables are expressed as ratio to the corresponding value in the baseline without shocks ($\xi = 0$). The computation is based on the following values for the model's parameters: $\theta^{gov} = 1$, $\theta^\tau = 1$, $\phi = 1.07$, $\eta_1 = 1$, $\epsilon = 0.14$, $\alpha = 0.33$, $\mu = 0.3$, $d = 0.49$, $\beta = 0.2$, $\gamma = 4.76$.

fiscal policy, i.e. to manage aggregate demand. If public wage is counter-cyclical it means that it is more sluggish in the terminology of the model, and hence corruption may increase with its long-term negative consequences.[10] On a contrary, counter-cyclical purchase of goods and services or public investment reduce the budget allocated to each public official, and as a result, provided public officials' salary remains the same, corruption may decrease (or increase more moderately). Deregulation and structural reform may also decrease the budget per official, and consequently have similar effect.

Figure 1 also demonstrates another simple but important point. The aggregate productivity shocks increase output in equilibrium, but not by as

---

[10]This concerns only the average public wage, not the public employment. If employment falls this may actually decrease corruption.

much as they would in case corruption remained unchanged. For example, if corruption remained as in the baseline, a shock of 2.5 would increase output by 2.5 times. Instead, the output increases only by 1.5 times. The difference is lost due to corruption. What we observe in reality is the joint effect of corruption and shocks on output. An important implication of this is that it is hard to pin down the actual productivity shocks from the GDP fluctuations alone.

Since corruption decreases output during boom times (and vice-versa during recessions) one may say that it is a counter-cyclical tool itself. Technically this is so, but it is by far not the most efficient stabilizer. First, increased corruption is a pure efficiency loss. Instead of the output loss due to corruption, favorable macroeconomic environment could be used to accumulate buffers (fiscal space or international reserves), which will be needed when the environment becomes more adverse. Second, corruption is likely to have long-lasting effect also on steady-state productivity. It reduces stock of public capital (as opposed to counter factual with the baseline corruption) and hence productivity of labor and private capital. It may also worsen the perception of the government policies by households and firms, including international investors. These perceptions tend to be persistent.[11] It also worsens income inequality, which may undermine sustainability of economic growth.

4   Empirical evidence

We now take the models to the data and check if there is any empirical evidence that the "growth-to-corruption" effect is present. The empirical work on the topic is challenging, in particular because it is really hard to identify exogenous productivity shocks in the data. We take parsimonious approach and use only annual cross-country data. There is a significant space for further empirical exploration of this issue (for example, using firm or sector-level data, and also on identifying the shocks). It is left for future research.

We present few simple pieces of empirical evidence in Figure 4 and Tables 2-6, which combined together support our theoretical conjectures.

The first piece of evidence is presented in Figure 4. It depicts average levels of bribery across the world against three time periods: 2006-2008, when

---

[11]The perceptions are not in the model, but the consideration is staightforward

most of the economies in the world were booming (a period of positive productivity shocks); 2009-2010, when most of the economies where in recession (a period of negative productivity shocks); and 2011-2016, which is a period of partial and slow recovery from the Great Recession. One can call 2011-2016 a period of small/moderate productivity shocks. Bribery is measured from the World Bank Enterprise Surveys as a percent of surveyed firms in the economy, which paid a bribe during the year of the survey. The sample of participating countries consists of 140 mostly low and middle income economies, years covered are 2006-2016. In most countries the survey was done more than once. See Table 1 for definition and summary statistics.

According to Figure 4, bribery was at its highest on average during the boom of 2006-2008. During the crisis of 2009-2010 it went sharply down from 22% to 17%. Then, when economies started to recover, bribery went up too, but it has not yet reached the pre-crisis levels on average. We can observe similar pattern by also looking at only resource-rich countries. In 2011-2014, when commodity prices recovered to the pre-crisis levels and sometimes even higher, the bribery in RRCs was more than 30%. When the prices sharply fell in 2015-16, corruption followed too. These patterns are consistent with the model, and without "growth-to-corruption" effect they would suggest that corruption actually helps the economy.[12]

The second piece of evidence are several regressions that are reported in Table 2. The general specification that we use is:

$$< corruption >_{it} = \beta_0 + \beta_1 * < GDP\ per\ capita >_{it} +$$
$$+ < output\ gap >_{it} + < terms-of-trade\ gap >_{it} + \psi_{it} \quad (35)$$

In Table 2 we regress bribery on the GDP per capita (proxy for the level of development) and two proxies for the productivity shocks. The first proxy is the output gap, which we obtain from country GDP data by simply running a Hodrick-Prescott filter with $\lambda = 6.25$ for each country and by using IMF WEO's forecasts to reduce the end-point bias in 2016. The output gap reflects the business cycles developments, the demand shocks which hit the productivity in short run. The second proxy is the terms-of-trade gap, which is simply demeaned net barter terms-of-trade index as measured by the World Bank (2000=100). Higher values of the index mean better ratio of export to import prices for the country. The ToT-gap reflects mostly

---

[12]The mean differences between the periods are not always statistically significant, but still, one may ask why don't we observe the opposite relationship
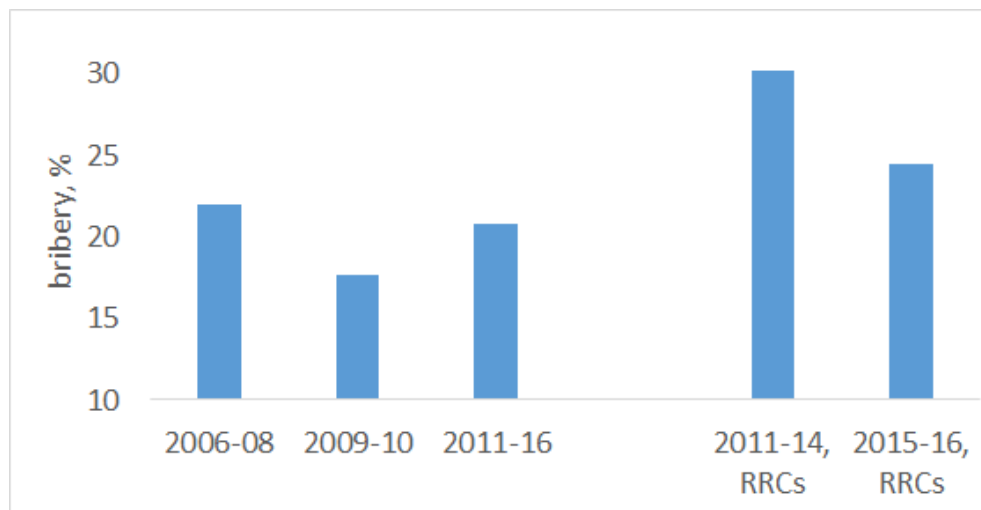
Figure 4: Corruption during booms and busts: Cross-country averages

Note Average total bribery levels during selected time periods. Datasource: WBES. See definition in Table 1. RRCs - resource-rich countries according to the IMF's definition (International Monetary Fund, 2012).

Table 1: Variables in regressions: Summary Statistics

Name	Explanation	Source	N	mean	s.d.	p(10)	p(50)	p(90)
bribery, total	% firms paid a bribe during period	WBES	240	19.9	16.9	3.5	15	44
bribery, procurement	% firms asked for a bribe in procurement	WBES	301	29.9	21.7	6.5	26.2	60.3
bribery, tax inspection	% firms asked for a bribe by tax inspector	WBES	308	20.9	20.3	1.4	14.4	55.1
WGI CoC	Control of Corruption Index (higher = better)	WGI	3015	0	1	-1.1	-0.3	1.4
TI CPI	Corruption Perception Index (higher = better)	TI	2633	4.3	2.2	2.1	3.6	8
shadow economy	% firms competing against informal sector	WBES	55.1	19	29.7	55.6	77.9	
GDP per capita	in thousands 2011 PPP	WB WDI	4803	15.1	18.5	1.4	8.2	38.6
GDP per capita growth	geometric average over a period, %	own	4608	2.1	6.4	-3	2.2	7.2
output gap	% of potential GDP (HP-filter on annual data)	own	5352	0	3.1	-2.3	0	2.4
ToT gap	net barter terms-of-trade index demeaned (2000=100, higher = better)	WB WDI	4838	0	32.6	-32.4	-1.3	31.4

Notes: All summary statistics over annual data. Abbreviations: WBES - World Bank Enterprize Surveys, WGI - Worldwide Governance Indicators, TI - Transparency International, WB WDI - World Bank's World Development Indicators. WBES data are available only for 2006-2016.

the developments of commodity prices, which is also an important source of productivity shocks. The idea here is that commodity price cycles are usually longer than business cycles, so we simply remove the long-term (sixteen year) average. We run several specifications - adding variables one by one, then adding year fixed effects, then checking the dynamic relationship, and then splitting the sample on RRCs vs. non-RRCs.

The results in Table 2 are also suggestive of the "growth-to-corruption" effect. First, as expected higher level of development (higher GDP per capita) is associated with lower corruption. This is consistent through all specifications. Controlling for the level of development, larger output gap (economy being above potential) is associated with higher bribery. This is direct evidence of the "growth-to-corruption" effect, and this result is also consistent through all specifications. Taking it as causal, one percentage point increase in output gap is expected to increase bribery by 1.3-2 percentage points, which is about a 10% increase from the world's average (see Table 1). The evidence on terms-of-trade gap is less conclusive. Although the sign of the coefficient is as expected (in columns (2) and (3)), the statistical significance is marginal and only in case year fixed effects are added. Adding the dynamics (column 4) does not change much for the output gap (its first lag is insignificant), but suggests that ToT gap affects corruption with a lag (the 1st lag is significant). The latter effect seems to be driven exclusively by the resource-rich countries (column 5 vs. column 6), whereas the result on output gap survives for both RRCs and non-RRCs. We tried adding other potential determinants of corruption to the regressions (for example, proxies for education), but it did not change the overall pattern.[13]

In Table 3 we explore bribery in different sectors of the economy, as well as the response of shadow economy to the shocks, while the general specification is as in (35). Our model suggests that corruption is mainly driven by the embezzlement, or misallocation of public funds by public officials. This is primarily corruption in procurement. At the same time, tax evasion is not as responsive to shocks as corruption. This may also mean that bribery to

---

[13]I also tried running fixed effects, but the results were inconclusive. Similarly to OLS, the signs of coefficients on output gap and ToT gap were positive, but neither of the coefficients were significant. Bribery is a slowly changing variable. In addition, both bribery and shocks are measured with significant measurement error, which is exacerbated under fixed effects. At the same time, the sign on GDP per capita changes the sign, which suggests that this variable partly captures the "growth-to-corruption" effect, and it actually dominates the relationship for a relatively short time span of 2006-2016.

26

Table 2: Corruption and aggregate productivity shocks

	all countries				RRCs	non-RRCs
	(1)	(2)	(3)	(4)	(5)	(6)
log GDP per capita	-6.94***	-7.29***	-7.81***	-7.94***	-5.39**	-7.15***
	(1.03)	(1.09)	(1.14)	(1.13)	(2.36)	(1.26)
output gap, % GDP	1.34***	1.33***	1.53***	1.59***	2.21**	1.34**
	(0.50)	(0.48)	(0.57)	(0.56)	(1.08)	(0.52)
terms of trade gap		0.06	0.08*	-0.08	-0.01	-0.65***
		(0.05)	(0.05)	(0.09)	(0.10)	(0.19)
L.output gap, % GDP				0.06	-0.44	0.69
				(0.51)	(1.16)	(0.63)
L.terms of trade gap				0.19**	0.18*	0.52***
				(0.08)	(0.11)	(0.20)
Constant	80.07***	83.05***	73.82***	74.92***	72.10***	75.73***
	(9.37)	(9.87)	(11.00)	(11.30)	(24.80)	(12.00)
year effects	No	No	Yes	Yes	Yes	Yes
Observations	238	218	218	218	71	138
R-squared	0.24	0.26	0.31	0.33	0.29	0.47

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable - bribery, total. See definitions in Table 1. Method of estimation - OLS. Regressions with additional controls (f.e. education) have been tried. Results (signs and magnitudes of coefficients of interest) are qualitatively similar.

tax inspectors should be less responsive. Columns 5 and 6 of Table 3 clearly demonstrate that the shadow economy, also measured from WBES, is not responsive to output gap or ToT gap. The evidence on bribery in procurement vs. tax inspection is less clear, but also supportive of the model. The coefficient on ToT gap is positive and significant in case of procurement, but insignificant and even negative in case of tax inspection. The coefficient on output gap is only marginally significant and positive for both types of bribery, although the magnitude of the point estimates is larger for procurement.[14].

Table 4 looks at other measures of corruption as dependent variables - WGI's Control of Corruption Index and TI's Corruption Perception Index. As opposed to the objective (actually experienced) measurement of bribery by WBES, these two measures are based mostly on subjective data - experts' perception about corruption in a country. While the coefficient on ToT gap is significant and the sign is as expected,[15] neither of the measures links corruption to the output gap. The reason might be that faster growing economies are (sometimes wrongly) perceived by experts as less corrupt, unless the growth is driven by easily observed improvement in terms-of-trade.

---

[14]Note that bribery in procurement and tax inspection are measured differently from the total bribery. For total bribery the firms are asked if they actually paid bribes. For bribery in procurement and tax inspection the firms were asked if they were expected to pay bribes. This may increase the measurement errors in the latter, and hence worsen the preciseness of the estimation

[15]Note that for both CoC and CPI higher value means less corruption

27

Table 3: Corruption in procurement vs. shadow economy and corruption in tax inspection

	bribery procurement		bribery tax inspection		shadow economy	
	(1)	(2)	(3)	(4)	(5)	(6)
log GDP per capita	-6.73***	-6.41***	-5.22***	-8.43***	-7.18***	-7.03***
	(1.25)	(1.34)	(1.21)	(1.03)	(1.17)	(1.12)
output gap, % GDP	1.21*	1.16	0.71	1.06*	-0.34	0.10
	(0.66)	(0.82)	(0.58)	(0.59)	(0.48)	(0.52)
terms of trade gap	0.13**	0.14**	-0.08*	0.04	0.03	0.01
	(0.06)	(0.06)	(0.05)	(0.04)	(0.05)	(0.05)
Constant	88.65***	83.08***	67.41***	119.69***	116.36***	109.71***
	(11.26)	(12.60)	(10.97)	(10.00)	(10.25)	(10.48)
year effects	No	Yes	No	Yes	No	Yes
Observations	277	277	284	284	208	208
R-squared	0.14	0.19	0.09	0.48	0.14	0.30

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Dependent variables indicated in the first raw. See definitions in Table 1. Method of estimation - OLS.

Table 4: Bribery vs. corruption perception

	WGI CoC		TI CPI	
	(1) all observations	(2) WBES sample	(3) all observations	(4) WBES sample
log GDP per capita	0.56***	0.56***	1.30***	1.30***
	(0.01)	(0.01)	(0.03)	(0.03)
output gap, % GDP	-0.00	-0.00	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
terms of trade gap	-0.00***	-0.00***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-5.09***	-5.07***	-7.62***	-7.61***
	(0.10)	(0.10)	(0.24)	(0.24)
year effects	No	Yes	No	Yes
Observations	2552	2552	2384	2384
R-squared	0.50	0.50	0.53	0.54

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Dependent variables indicated in the first raw. See definitions in Table 1. Method of estimation - OLS. Columns (1) and (3) use all observations available; columns (2) and (4) use only observations, which are also available for estimation in Table 2.

The last piece of empirical evidence that we present in Tables 5 and 6 is a set of elementary growth regressions, where corruption is an explanatory variable:

$$< Av.\ GDP\ per\ capita\ growth >_{it} = \beta_0 + \beta_1 * < Av.\ corruption > it +$$
$$+ \beta_2 * < GDP\ per\ capita >_{i,t-1} + \psi_{it} \quad (36)$$

The main goal here is to explore the relationship between growth and corruption in settings, where unaccounted exogenous productivity shocks have various degrees of importance. The expectation is that in settings with smaller importance of shocks the growth-corruption relationship should be less

biased by the "growth-to-corruption" effect, and hence we expect negative significant coefficient with increasing absolute magnitude. We use two ways to vary the importance of shocks. First, we average the data over different time spans. The longer is the time span the smaller should be the influence of temporary shocks as they offset each other in the long run. Second, we restrict the estimation sample to countries, which are likely to be less exposed to the exogenous shocks.

Table 5 shows the results on restricted and unrestricted samples, and for three time spans - 20 years, 10 years, and 5 years. Column 1 in all three sub-tables shows the growth regressions on unrestricted sample. The coefficient on control of corruption is negative (opposite to expected) and insignificant. For 5-year span even the convergence result does not hold - the coefficient on initial log GDP per capita is insignificant. In column 2 we exclude low income countries as classified by the World Bank in 2010. LICs are more likely to be more sensitive to exogenous shocks due to their reliance on undiversified exports, and often absence of buffers to counteract the shocks. The coefficient on CoC is now positive for 10-year and 20-year span, but it is still not significant. Excluding the RRCs, as we do in column 3, increased the coefficient on CoC further, but it remains insignificant. Finally, if also small countries (those with population less than 0.5 mln) are excluded, the relationship between corruption and growth becomes as expected by most economists.

Longer time span also improves the results of the growth regressions. In Table 5 the coefficients under the 20-year span are always larger in magnitude than those under smaller time spans. In Table 6 the time spans are compared when only one time period is used for the estimation, to equalize the number of observations, but the specification is the same as in (36).[16] When only one period is used for the estimation the advantage of the 20-year span becomes much clearer. It is the only time span under which the growth-corruption is as we expect. Neither 10-year nor 5-year spans produce satisfactory results. This result holds both when the period ends in 2015 and when the period ends in 2010. Ugur (2014) also describes the better performance of longer time spans when estimating growth-corruption relationship, but he does not explain this phenomenon.

---

[16]In Table 5 we used all available observations. For example, if the estimation period is 1995-2015, for a 20-year span this would still mean only one period for estimation. For a 10-year span this means two periods - one ending in 2015 and one ending in 2005. For a 5-year span this means four periods. In Table 6 only one period is used for all time spans.

Table 5: Corruption in growth regressions: Importance of time span and sample restrictions

	(1)	(2)	(3)	(4)
				no LICs,
	all		no LICs,	no RRCs,
	countries	no LICs	no RRCs	large
WGI CoC, 20y average	-0.09	0.06	0.39	0.70**
	(0.26)	(0.26)	(0.27)	(0.27)
L20.log GDP per capita	-0.45**	-1.15***	-1.23***	-1.78***
	(0.20)	(0.26)	(0.27)	(0.29)
Constant	6.41***	13.13***	13.68***	18.93***
	(1.78)	(2.37)	(2.46)	(2.59)
Observations	174	129	95	76
R-squared	0.08	0.23	0.25	0.42
	(1)	(2)	(3)	(4)
				no LICs,
	all		no LICs,	no RRCs,
	countries	no LICs	no RRCs	large
WGI CoC, 10y average	-0.21	0.03	0.37	0.72***
	(0.23)	(0.25)	(0.24)	(0.26)
L10.log GDP per capita	-0.32*	-1.12***	-1.24***	-1.84***
	(0.18)	(0.25)	(0.25)	(0.28)
Constant	5.32***	13.10***	13.95***	19.79***
	(1.58)	(2.29)	(2.32)	(2.58)
Observations	362	270	193	154
R-squared	0.04	0.13	0.16	0.27
	(1)	(2)	(3)	(4)
				no LICs,
	all		no LICs,	no RRCs,
	countries	no LICs	no RRCs	large
WGI CoC, 5y average	-0.28	-0.15	0.23	0.61**
	(0.19)	(0.20)	(0.22)	(0.24)
L5.log GDP per capita	-0.21	-0.87***	-1.11***	-1.76***
	(0.15)	(0.21)	(0.23)	(0.26)
Constant	4.39***	10.79***	12.89***	19.19***
	(1.37)	(1.92)	(2.10)	(2.44)
Observations	741	554	388	310
R-squared	0.02	0.07	0.09	0.17

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is GDP growth over a corresponding period (time span): 20 years in first sub-table, 10 years in second, 5 years in third. See definitions of variables in Table 1. Method of estimation - OLS. Gradual restrictions on sample are applied: column (1) - all countries; (2) - all except low income countries (LICs); (3) - no LICs and no resource-rich countries; (4) - no LICs, no RRCs, and no small countries (population less than 0.5mln). Period of estimation - 1995-2015, e.g. one period is used for 20 years time span, two periods for 10 years, four periods for 5 years.

Table 6: Corruption in growth regressions: Longer vs. shorter time span

	last year - 2015			last year - 2010		
	(1)	(2)	(3)	(4)	(5)	(6)
	20y	10y	5y	20y	10y	5y
WGI CoC, 20y average	0.70**			0.83***		
	(0.27)			(0.28)		
L20.log GDP per capita	-1.78***			-1.49***		
	(0.29)			(0.32)		
L10.log GDP per capita		-1.75***			-1.36***	
		(0.32)			(0.35)	
L5.log GDP per capita			-1.66***			-1.73***
			(0.42)			(0.42)
WGI CoC, 10y average		0.38			-0.07	
		(0.29)			(0.33)	
WGI CoC, 5y average			0.59*			-0.00
			(0.35)			(0.38)
Constant	18.93***	18.87***	17.83***	15.66***	15.77***	19.02***
	(2.59)	(3.03)	(3.96)	(2.87)	(3.22)	(3.94)
Observations	76	78	78	65	78	78
R-squared	0.42	0.40	0.21	0.27	0.40	0.37

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is GDP growth over a corresponding period (time span): 20, 10 or 5 years. See definitions of variables in Table 1. Method of estimation - OLS. In all regressions the sample excludes LICs, RRCs, small countries. Only one year is used in estimation: 2015 in columns (1)-(3), 2010 in (4)-(6).

The conclusion of the empirical section is that the "growth-to-corruption" effect is likely present in the data, and it biases the growth-corruption relationship making corruption look less harmful. Therefore one has to be extremely cautious when using growth regressions to estimate the effect of corruption on growth unless aggregate productivity shocks are properly identified and controlled for. Averaging data over longer time spans may help, although even 10-year spans do not perform particularly well. Finally, even a 20-year span does not perform well if the sample is not restricted to countries, which are likely less exposed to the shocks.

5 Conclusions

This paper provides an explanation of weak empirical relationship between economic growth and corruption. The potential reason is the "growth-to-corruption" effect. When economy is hit by exogenous productivity shocks this likely changes corruption and output in the same direction. For example, a favorable shock increases tax revenue and hence opportunities for corruption. It also makes the economy grow faster. This positive correlation biases the results in growth regressions and weakens the effect of corruption (sometimes making it even positive).

To demonstrate our point we build two models - an illustrative but par-

simonious stylized model and comprehensive but complex general model. In both cases an exogenous productivity shock increases tax revenue, because tax evasion does not respond to the shock much. Increased tax revenue is allocated to public officials, which increases the share that they embezzle. This result depends on how responsive is public salary to productivity shocks. The more sluggish is the salary the larger is the increase in corruption. This makes public wage bill not very efficient countercyclical fiscal policy tool, as opposed to purchase of goods and services and public investment.

We also support our findings by the empirical investigation. We find evidence that is consistent with the presence of "growth-to-corruption" effect in the data, although more work is needed to properly identify the productivity shocks and use less aggregate data. The "growth-to-corruption" effect biases the results in growth regressions, so has to be cautious when using them. Their performance can be improved by averaging data over longer time spans and restricting the sample to countries, which are less exposed to shocks.

References

Huntington, S. (1968). *Political Order in Changing Societies* (Yale University Press, New Haven, 1968).

International Monetary Fund (2012). Macroeconomic policy frameworks for resource-rich developing countries, IMF Policy Paper.

Ivanyna, M., A. Mourmouras, and P. Rangazas (2016a). Corruption, public debt and economic growth, unpublished paper.

Ivanyna, M., A. Mourmouras, and P. Rangazas (2016b). The culture of corruption, tax evasion, and optimal tax policy. *Economic Inquiry* 54 (1): 520–542.

Mauro, P. (1995). Corruption and growth. *Quarterly Journal of Economics* 110 (3): 681–712.

Olken, B. and R. Pande (2012). Corruption in developing countries. *Annual Review of Economics* 4: 479–509.

Porta, R. L. and A. Shleifer (2008). The unofficial economy and economic development. *Brookings Papers on Economic Activity* 39 (2): 275–363.

Svensson, J. (2005). Eight questions about corruption. *Journal of Economic Perspectives* 19 (5): 19–42.

Ugur, M. (2014). Corruption's direct effects on per-capita income growth: A meta-analysis. *Journal of Economic Surveys* 28 (3): 472–490.