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CORRUPTION IN AN UNSTABLE ENVIRONMENT*

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Abstract

In this paper we study the influence of economic stability on the level of corruption in a country, where high stability is defined as a low level of variance in economic output growth. We present a political competition model with exogenous shocks to economic output where politicians can decide about the level of corruption and an election is held within the framework of a Bayesian game. Corruption is assumed to be harmful to the economy and politicians try to maximize income from corrupt activities as well as the probability of getting reelected. We show that independent of the absolute size of economic output growth a low degree of economic stability yields a high level of corruption and vice versa. Thus we conclude that not only does corruption influence economic activity, but also the opposite effect might exist, namely that exogenously caused fluctuations of output influence the readiness of politicians to behave in a corrupt manner. To support our theoretical findings we additionally carry out a cross-country empirical analysis of GDP growth variance and corruption and come to results confirming our thesis.

Keywords and Phrases: **Corruption, Political Competition, Bayesian Game, Cross Country Study on Corruption**

JEL-Classification: **D72, D73, D83**

1 Introduction

There is almost no country which has not been hit by some sort of corruption at some time of its history. Even today, where corruption no longer

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appears to play a mayor role in western economies, no one would claim that it has been totaly defeated. For developing and transition countries things are much worse. Corruption is more pervasive there and in some countries it is blamed for having a severe negative impact on economic activity. This impact of corruption on growth and stability is widely studied in the literature but as far as we know there is little work yet in the opposite direction, i.e. in examining the influence of the economic (in)stability of a country on the level of corruption.

In this paper we present and test a model addressing this gap. Therefore we set up a two period model of political competition with asymmetric information and two types of politicians, where incumbents have to decide about the level of corruption and economic output is affected by their decision. We will show that in a Bayesian equilibrium, the incumbent chooses a higher level of corruption if the variance of economic output is high and a lower level if it is low. Also we will show that high levels of corruption are more likely if regular legal remunerations for being in office are low. Thus we conclude that a high level of economic instability should foster corruption and we present an empirical test of our suggestion.

The paper is organized as follows: First we take a look at the related literature to define the notion of corruption and to track alternative explanations for the appearance of corruption. Then we present the model in section two and work through the game and the propositions. Afterwards we run an empirical test of our model in section three to support our results. A short conclusion and an outlook end the paper and an appendix discusses a variation of the model.

1.1 Corruption

Corruption is a more or less prevalent phenomenon in any society that runs a political apparatus to control the allocation and distribution of limited resources, rights and claims within its economic system. Whenever the control of public decision makers by the society either by direct observation or by moral norms is not absolute, there is room for the former to behave opportunistically and to take inefficient or unjust decisions in exchange for payments or other grants from the privileged parties. The sum of this socially undesirable behavior is what we call corruption in our paper.

To get a better understanding of the types of corruption and how they might lead to inefficient outcomes, we follow Rose-Ackerman (1999) and distinguish five genres of corruption: 1. Bribes to equate differences in supply and demand stemming from legal restrictions: In this case bribes raise the price of a good in excess demand and with fixed supply until demand is lowered to the available amount of supply. Therefore some rents are transferred and pocketed by the corrupt official. Inefficiency occurs if the considered party is different from the one with the highest valuation. 2. Bribes as incentive payments are payed when it depends on the goodwill of officials whether demanded work is done fast or slow (*"speed money"*). Alternatively bribes may be payed to slow down the work of officials concerning competitors. The second case is sometimes even more "effective" for the bribing party, as it is often easier for an official to slow down a process than to accelerate it. Inefficiency results from wrong incentives and the creation of additional *"road blocks"* by officers to increase their veto power. 3. Bribes to lower costs. This means that an official is payed to be indulgent when controlling for example safety standards. The inefficiency might result from ignoring external effects that have been internalized by laws. 4. Bribes to obtain limited concessions which otherwise would have been sold in an auction or a beauty contest. This leads to misallocation if not all parties have the same readiness to bribe. Otherwise the result would be the same as in an auction, but rents would go to the official and not to the state. 5. Bribes to buy political influence and votes. Here lobbies pay bribes to politicians so as to strengthen their position. In a broader way one could also put politicians' favors to special interest groups in exchange for votes or campaign contributions into this category.

Whereas probably hardly anybody doubted the negative effects of corruption in practice, from a theoretical point of view it was not clear for a long time whether corruption is really that distortionary. Some economists (see for example Leff (1964) or Huntington (1968)) even defended the use of bribery as an efficient, welfare enhancing mechanism. The first argument was that bribes provide a motivation for officers to work harder in so far as they act at a piece rate. They also claimed that "speed money" avoids bureaucratic delays and bribes for concessions work as an auction-like allocation device, where scarce resources are given to the parties with the highest valuation and thus the highest bribe offer. According to this school bribes should have no more negative effects on the economy than other transfers, for example taxes. Interesting as it is, this theory falls short of the fact that the access to such a bribe-driven market could very likely differ for various demanding parties either for differences in moral considerations or for different levels of trustworthiness, connections to officers and available information. It also ignores the negative incentives for officers induced by corruption, as they might try to strengthen their position by setting up additional hurdles. From a contract-theory perspective, bribe "contracts" have the disadvantage of not being enforceable by the trade partners.

Shleifer and Vishny argue that corruption is more costly than taxation because of the secrecy premise, i.e. the necessity to hide away corrupt activities from the public and the law. The secrecy premise thus allocates resources for setting up and covering secure information channels (see Shleifer and Vishny (1993)). Other empirical and theoretical studies as from the United Nations (1989) or from Klitgaard (1991) confirm the suspicion that corruption is a wasteful activity and should be banned wherever possible. Another implication of Leff and Huntington's theory is that corruption should especially exert its pretended positive effect in inefficient bureaucratic environments. This argument can be cancelled out by a empirical study by Mauro (1995), who shows that the correlation between growth and corruption is far from being significantly different in countries with highly efficient and with less efficient bureaucracies, whereas according to Leff and Huntington growth should be closer correlated to corruption in less efficient bureaucracies, because they should work better with the "help" of corruption. In our paper we stick to the view of corruption as a "bad" activity, as we refer to a negative effect of corruption on economic output in a common way.

In the terms of informational economics, corruption could be seen as a principal agent problem with the society as the principal and the politicians and officers as the agents. Under asymmetric information about the agents' actions there is no way to provide perfect incentives without handing over the entire surplus to them. Fixed remunerations and benefits given, only transparency and monitoring (reduction of asymmetry), means of punishment (deterrence), or some "moral codex" (altering of the agent's utility function) can reduce the level of corruption.

All points play an important role in the determination of the levels of corruption observed in reality. For example the means of control should be higher in societies with a high level of democracy and free media than in autocratic countries with suppressed media. Also the society in autocratic systems has fewer possibilities to punish decision makers than in democracies. The model of Rasmusen and Ramseyer (1994) addresses this point and thus claims that corruption should be higher in autocratic systems.

But even in the most autocratic society the people *has* a possibility to discipline the government - for example by threatening a revolution. Of course this threat is quite poor and probably less effective than the possible sanctions in a democratic country. Still it may play a role in the behavior of corrupt decision makers in autocratic countries and could well bound away the level of corruption from the maximum level. And as the level of corruption differs widely both among autocratic and among democratic countries, the degree of democratization cannot be the sole determinant of corruption.

The last point, the differences in moral norms, certainly also plays an important role in the explanation of corruption. Some even consider it to be the main reason for degree of corruption and claim that the effects of different constitutions and economic circumstances are negligible compared to those of different social norms. Bardhan (1997) gives an example of the different views of corruption by Westerners and Asians. The former perceive the regular *"baksheesh"* payments in Asian countries as corrupt, whereas the latter find the high degree of monetarization even in personal transactions in western countries corrupt. The differences could be explained by the comparatively high level of individualization in western societies and by the long tradition of mutual gift exchange at all levels of society in many Asian countries.

Even if they sound somewhat tautological, it has to be admitted that explanations related to cultural differences are capable to explain differences in the level of corruption even *within* one country or society, for example between northern and southern Italy. Other theories and examples of this type are provided by Putnam (1993) for Italy, by Yang (1989) for the Chinese society and by others.

However, in our opinion cultural differences rather enforce existing tendencies of corruption stemming from the principal agent relationship, than being the sole source of it. An argument supporting this view is that there are many counter examples where culturally related areas show huge differences in the level of corruption (e.g. Singapore compared to Malaysia or Indonesia, or many examples where corruption differs between urban and rural areas within one cultural homogenous region).

Because corruption seems to be much more common in developing and poor countries, many studies concentrated on the connection of corruption and growth. It is argued that economies with low output and slow growth are more susceptible to corruption because the controlling power of the executive is weak and people on all levels of societies are in great need for extra incomes.

Further ideas concerning the corruption-growth relationship are highlighted for example by Ehrlich and Lui (1999) or by DelMonte and Papagani (2001). Mauro (1995) looks for empirical evidence in this direction, and finds a negative association between perceived corruption and the investment rate in a cross-country study. The intuition is that it is expensive and risky to invest in highly corrupt countries, and therefore growth should be low, whereas the resulting poverty fosters corruption even further and so on.

But on the other hand, Bardhan (1997) points out that it can not simply be inferred that low economic growth is the only source for corruption, as there are many cases where corruption is rising sharply although growth is relatively high and incomes are rising. Many of the eastern European transition economies as well as some south-east Asian states fall into this category.

These examples also contradict the argument of many liberal economists that corruption is spawned by regulatory states because the level of corruption increased substantially after market reforms in recent years for example in post-communist Russia or China.

Other models stress the idea that corruption shows a sort of a reinforcing effect, i.e. that it pays more to be corrupt when everybody else is. Thus corruption is expected to spread fast once a certain critical level is reached and on the other hand it should be difficult to introduce corruption in an extremely clean country. For example Andvig and Moene (1990) come to this result in their model by pointing out that for a corrupt officer it is cheaper to get detected by a corrupt superior than by a clean one. Rasmusen and Ramseyer (1994) support this view of corruption as a collective action problem with the results of another model.

The intuition of this theory is quite appealing as it is easy to imagine that a newly installed and so far innocent officer in Bangladesh is more likely to accept a bribe than one in Finland. Nevertheless it fails in describing how the level of corruption was able to reach this critical point in some countries and not in others.

Hence there are some interesting and plausible approaches to the phenomenon of corruption, most of them addressing cultural, constitutional or economic differences between countries and some of them relating growth and wealth to the level of corruption. Yet none of the theories can fully explain corruption and as far as we know none examined the relationship between economic (in)stability and corruption. Our model wants to address this gap and show why it is plausible to think of economic instability as a possible additional source of corruption.

To investigate this issue we define stability as the amplitude of economic output growth around a long term drift rate. A country with a low variance of output growth (i.e. a relatively monotone output path) is called *stable*, one with a high variance (i.e. a relatively non-monotonic output path) is called *unstable*. The stability of output enters exogenously in our model, and one can think of it as being an effect of the state of the world economy, exchange rates, foreign relationships, prices of raw materials, internal frictions from reorganization processes, natural disasters and the like. The idea of output stability being exogenous is supported by a paper of Easterly et al. (1993), where they find that most of the variation in growth rates is due to random shocks and not to some special policy.

2 The model

For this paper we use a two period political competition model where an incumbent can decide on the level of corruption and faces some elections[1] at the end of the first period.

2.1 Model Structure

There are two periods $t = 1$ and $t = 2$ and two possible levels of corruption in each period, $l_t \in \{\underline{l}, \bar{l}\}$, $l_t = \underline{l} = 0$ means there will be "no corruption" in

[1]Basically the instrument of election is only a democratic device to discipline politicians. If one thinks about the threat of revolution being a disciplining device in autocratic countries, as mentioned above, one can expand our model even to non democratic countries. The *"election"* there would be the decision whether to revolt or not. Of course the disciplining effect of a threat of revolution should be small due to the high private costs of such a revolution, but in a different context Acemoglu and Robinson (2000) show in a quite elegant model how this threat can suffice to cause the ruling elite of an autocratic country to extend the franchise in order to calm the people. Similarly the ruling class might restrict corruption in our model to keep the people quiet.

period t and $l_t = \bar{l}$ means that a high level of corruption is chosen in period t.[2]

Definition of Players

There are two types of politicians, a *"good"* one ($\theta = g$) and a *"bad"* one ($\theta = b$).
The overall utility function of politicians is

$$U_P = \tau_1(u_0 + a_\theta l_1) + \tau_2 \delta(u_0 + a_\theta l_2) \quad (1)$$

τ_t indicates whether P is in office in period t ($\tau_t = 1$) or not ($\tau_t = 0$). u_0 is the "base" utility or ego-rent of being in office, i.e. the salary, social status and so on. This utility is fixed and cashed in for certain in every period the politician is in office. The "good" politician derives negative utility from being corrupt, as he might feel guilty or fear punishment, i.e. he will stick to his promise not to be corrupt. The bad politician does not care about external effects or morality considerations and gets direct positive utility from a high level of corruption. In the model this is expressed by $a_g < 0$ and $a_b > 0$. a_g and a_b denote the gains-factor from corruption for good respectively bad politicians. All politicians are drawn from a large pool of politicians, where π is the fraction of "good" politicians in this pool. Future utility is discounted by δ.

The incumbent I of period 1 has to decide on the level of corruption l_1 in period 1 and on the level of corruption l_2 in period 2 for the case that he gets reelected.

Citizens derive utility U_V only from the performance of the economy, which is measured by economic output e. It is assumed that they all have strictly monotonic utility functions in output, so $U_V(e') > U_V(e) \Leftrightarrow e' > e$. Thus, citizens can be modelled by a representative voter V with utility function U_V. The only action the representative citizen takes is to vote at the end of period 1. Then, V can decide whether to confirm I in office or to elect a challenger C.

C is the challenger that is drawn out of the pool of politicians to face I in the election. If he gets elected he will be in office in period 2, therefore his only action is to set a level of corruption in period 2 if he is elected.

Economic Stability

[2]The level of corruption chosen can be thought of as the degree of the incumbent being corrupt himself or allowing his subordinate officers to be corrupt. If an incumbent decides to turn a blind eye on corruption in the governmental apparatus he will benefit from this by getting stronger support by his officers. In the other case, when he decides on low corruption he will not only loose the direct income of corruption, but his life will get harder because it is likely that support from his officers is lower when they experience stricter controls for their actions. Therefore in this model only the decision of the incumbent is considered and the officers are supposed to follow the decision of the government.

The economic output defines the voter's utility and is crucial as a signal about I's policy in period 1. The voter observes the change in economic output directly by comparing his utility at the beginning and at the end of period 1. However, the change in economic output is affected by three factors. First there is a drift rate d determining the long term growth rate of the economy. d is of no importance for the model itself but nevertheless we keep it for the empirical part. Second there is an exogenous shock s to the economy. s brings in the variance of output. Third we assume a negative impact of corruption on the performance of the economy. Therefore the change in economic output e is modelled as follows:

$$\Delta e = d + s - l \tag{2}$$

s has mean zero and is distributed with one of two possible density functions $h(\cdot)$ which have either high or low variance, where high and low variance of s are equally likely. For the computation of the equilibrium we assume $h(a, b)$ to be a uniform distribution on the interval $[a; b]$ in the remainder of the model: [3]

$$s \sim h(-\tilde{e}, +\tilde{e}) \text{ with } \tilde{e} \in \{\underline{e}, \bar{e}\}, p(\tilde{e} = \underline{e}) = p(\tilde{e} = \bar{e}) = \frac{1}{2} \tag{3}$$

$\tilde{e} = \underline{e}$ stands for a relatively *"stable"* economy, i.e. shocks are comparatively small, whereas $\tilde{e} = \bar{e}$ denotes an *"unstable"* economy which suffers large shocks to economic outcome. Think of a stable economy for example of a well diversified one, whereas an unstable economy could be a country highly dependent on one export good with large price fluctuations. We assume that $\bar{l} < 2\underline{e}$, i.e. the influence of the exogenous shock on the economy is not too small compared to the influence of corruption.

Information Structure

There are two types of uncertainty which the citizen is facing when making his electoral decision.

First the level of l_1 chosen by I cannot be directly observed by the citizen. It is assumed that corruption mostly takes place between government and only a few of the citizens in special positions, e.g. firm managers, lobbyists etc. Therefor the great majority does not know whether much or little corruptive activity is executed by the government.

However politicians and citizens observe $\tilde{e}$ at the beginning of period 1, as they know whether they live in a "stable" or "unstable" economy. Thus citizens know the maximum amplitude of the shock s, but they do not know its actual size. Also citizens naturally can observe their own utility after e incarnates. Uncertain of the origin of an income shock, they only can calculate

[3] in the appendix, a version of the model with a more natural normally distributed shock to economic output is discussed. Unfortunately this leads to some computational problems due to the characteristics of the normal distribution function.

probabilities for the chosen size of l_1. Thus e acts as a noisy signal about the action of I.

Second the types of I and C are not known a priori, but both have an initial reputation of being of "good" type denoted by α_I and α_C, i.e. $\alpha_i = p(\theta(i) = g)$, $i \in \{I, C\}$. α_I and α_C are independent of actual types and are drawn from the same cumulative distribution function F. F is common knowledge.

The Game

The players of the game are the incumbent, the citizen and the challenger. The timing of the game is as follows:
First, nature chooses the type of the incumbent $\theta(I)$, which is only observed by the incumbent I. Then, nature chooses $\tilde{e}$, which is observed by all players. Now, I must choose l_1, and nobody except herself knows her choice. Nature then draws s with $p(s = x) = h(x)$ and $s - l_1$ is computed as the net output, as we set $d = 0$ in the theoretical model. $s - l_1$ is observed by all players.
After the citizen and the incumbent receive their first-period utilities, an election is held, and the former has to choose between the incumbent I and the challenger C based on his beliefs about $\theta(I)$ and on α_C. C is drawn by nature from the pool of politicians (and only himself knows his type) and as mentioned above his initial reputation is drawn from F.
The winner of the election then chooses the second period l_2. Payoffs are realized and the game ends.

A strategy for the incumbent is the pair $l := (l_1, l_2)$ of decision rules about the degree of corruption in the first and (if reelected) the second period. I's choice is dependent on her type $\theta(I)$ and the state of the world $\tilde{e}$.
A strategy for the challenger is the decision rule l_2 if he is elected for the second period. His choice is dependent only on his type $\theta(C)$.
A strategy for the citizen is the voting decision rule v that specifies whether he votes for I ($v = I$) or C ($v = C$). The choice is dependent on his beliefs $\beta_I(e)$ about the incumbent's type after observing her initial reputation α_I and the signal e and on the challenger's initial reputation α_C. V compares α_C and β_I and chooses the candidate with the higher value. Thus the probability for I to get reelected is $F(\beta_I)$.

A perfect Bayesian equilibrium of the game is a set of optimal strategies for I, C and V and of consistent beliefs of the citizen about I's type.
It must satisfy the following properties:

- I chooses l such that $l(\theta(I)) = argmax_l EU_P$
- C chooses l_2 such that $l_2(\theta(C)) = argmax_{l_2}(u_0 + a_\theta l_2)$
- V chooses a voting rule v such that $v = argmax_v EU_V$ where V's second period utility is dependent on the type of the elected politician v

- V's posterior belief about I's type after observing the signal e, $\beta_I(e) = p(\theta(I) = g \mid e)$ is derived by updating using Bayes' rule and is consistent

2.2 Equilibrium

As we face a two period game, we can solve it by backward induction.

Proposition 1 *In a perfect Bayesian equilibrium as defined above, a "good" incumbent chooses $l_2 = \underline{l}$, a "bad" one $l_2 = \bar{l}$.*

PROOF

In the second period the behavior of the politician in power is clear. She does not have to worry about being reelected and will simply maximize her second period utility $u_0 + a_\theta l_2$. This leads to $l_2 = \underline{l}$ for $a < 0$ ("good" politician in power) and to $l_2 = \bar{l}$ for $a > 0$ ("bad" politician in power).[4]

□

In the first period, a "good" incumbent maximizes her expected utility. Her behavior will obviously depend on citizens' beliefs.
To rule out equilibria based on unnatural out of equilibrium beliefs, such as *"a low level of e indicates a low l_1"* which could lead to self fulfilling equilibria where even good politicians play $l_1 = \bar{l}$, we concentrate on equilibria with *monotonic beliefs* of citizens. This refinement was first used by Coate and Morris (1995) for situations where other refinements such as the equilibrium dominance argument by Cho and Kreps (1987) cannot be applied because of the noisy character of the signal. Basically it means that a higher economic output is believed to be produced more likely by a "good" politician and thus $l_1 = 0$ with a higher probability as if a low economic output is observed. Formally: $e' > e \Rightarrow \beta(e') \geq \beta(e)$, other things held constant. This concept sounds rather plausible in our case, as citizens know about "bad" politician's preferences and their negative impact on output. For further discussion see Coate and Morris (1995).

Proposition 2 *In a perfect Bayesian equilibrium with monotonic beliefs as defined above, a "good" incumbent chooses $l_1 = \underline{l}$.*

[4] Here we have an endgame effect, which allows us to solve the game by backward induction. However this assumption is not too unrealistic. First, many countries restrict the time for higher politicians to be in office, and second every politician faces a limited lifespan and an increasing probability of dying in each period, which should lead to the same results in a multi period game. Empirically it would be interesting to test whether corruption activities rise the closer incumbents get to their last possible period in office, in which - as in our 2nd period - they do not have to care about reelections anymore.

Proof

Under the assumption of monotonic beliefs both the direct utility from engaging in corruption decreases because $a_g < 0$, and the chance of getting reelected is non-increasing, thus the "good" incumbent will choose $l_1 = \underline{l}$.

□

Foreseeing this, citizens prefer to have a good politician in office in the second period, which would result in a higher expected level of e. Therefore they will vote for the candidate whom they consider to be good with a higher probability, thus $v = I \Leftrightarrow \beta_I(e) \geq \alpha_C$. Starting from their prior belief α_I they form $\beta_I(e)$ as follows:

$$\beta_I(e) = \frac{\alpha_I p(s - l = e \,|\, \theta(I) = g)}{\alpha_I p(s - l = e|\theta(I) = g) + (1 - \alpha_I)p(s - l = e|\theta(I) = b)} \quad (4)$$

$$= \frac{\alpha_I h_{\underline{l}}(e)}{\alpha_I h_{\underline{l}}(e) + (1 - \alpha_I)h_{\overline{l}}(e)} \quad (5)$$

where $h_{\underline{l}}(e)$ is the density function of e if $l_1 = \underline{l}$ and $h_{\overline{l}}(e)$ is the density for e if $l_1 = \overline{l}$. $h_{\underline{l}}(e)$ and $h_{\overline{l}}(e)$ are similar to the distribution function h of s but shifted by $\underline{l}$ resp. $\overline{l}$ to the left. For the case of uniformly distributed s this leads to

$$\beta_I(e) = \begin{cases} 0 & \text{if } e \in [-\tilde{e} - \overline{l}; \tilde{e}[\ , \\ \alpha_I & \text{if } e \in [-\tilde{e}; \tilde{e} - \overline{l}]\ , \\ 1 & \text{if } e \in]\tilde{e} - \overline{l}; \tilde{e}]\ . \end{cases} \quad (6)$$

In this case there is either no learning or full revelation of I's type.[5] For $e < -\tilde{e} - \overline{l}$ and $e > \tilde{e}$ beliefs are not defined but these cases cannot occur in the model, so this beliefs can be set to any value.[6]

The incumbent's first period behavior is determined by the maximization of I's overall expected utility which in turn depends both on I's choice of l_1 and on the citizen's belief. For a "good" incumbent it was easy to show that $l_1 = \underline{l}$ under monotonic beliefs, as both direct utility and the probability of getting reelected are decreasing in l_1. For the case of being "bad", I has to make a tradeoff between increasing his income in the first period by choosing $l_1 = \overline{l}$ as $a_b > 0$ and maximizing the probability of being reelected to get in favor of second period incomes by choosing $l_1 = \underline{l}$. To find his actual behavior,

[5]Again, see the appendix for a case with imperfect revelation of types. Anyway, this is only a matter of "elegance", as uniformly distributed shocks perfectly suffice to describe the effect under consideration.

[6]Note that the citizens can only punish the incumbent by voting her out of office and deprive her of second period benefits. However, if they could punish her arbitrarily hard, it would be possible to implement the first best, as there are cases where V can be sure that he is facing a bad politician.

we have to maximize overall expected utility as stated in equation (1), given that the citizen updates his beliefs according to equation (6).
If I's decision is $l_1 = \underline{l}$ for $\theta(I) = b$, then we are in a pooling equilibrium, where behavior does not depend on I's type, if I's decision is $l_1 = \bar{l}$ for $\theta(I) = b$, we are in a separating equilibrium, where the good politician stays clean and the bad one fosters corruption.

2.3 Impact of Stability

While solving for the optimal first period behavior of "bad" incumbents, we come to the main topic of the paper, the question of whether the stability of an economy will have any impact on the degree of corruption within this country. To answer this question we set up a Lemma and several additional propositions.

Lemma 1 *In a perfect Bayesian equilibrium with monotonic beliefs as defined above, an incumbent I with $\theta(I) = b$ chooses $l_1 = \underline{l} \Leftrightarrow \delta(\frac{u_0}{a_b} + \bar{l}) > \tilde{e}$.*

PROOF

The incumbent maximizes her expected payoff as follows:

$$l(\theta(I)) = argmax_l EU_P(\theta(I), l)$$

Thus, an incumbent with $\theta(I) = g$ chooses $l_1 = \underline{l}$. An incumbent with $\theta(I) = b$ chooses l_1 such that

$$\begin{aligned} l_1 &= argmax_{l_1} E(u_0 + a_b l_1 + p(v = I)\delta(u_0 + a_b\bar{l})) \quad (7) \\ &= argmax_{l_1} E(u_0 + a_b l_1 + F(\beta(e))\delta(u_0 + a_b\bar{l})) \\ &= argmax_{l_1} E(a_b l_1 + \int_{-\tilde{e}-\bar{l}}^{\tilde{e}} \beta(e)\, de\ \delta(u_0 + a_b\bar{l})) \end{aligned}$$

(8)

So, $l_1 = \underline{l}$ if and only if

$$EU_P(l_1 = \underline{l}) > EU_P(l_1 = \bar{l}) \quad \Leftrightarrow \quad (9)$$

$$\int_{-\tilde{e}-\bar{l}}^{\tilde{e}} \Big(p(e|l_1 = \underline{l})\beta(e|l_1 = \underline{l}) - p(e|l_1 = \bar{l})\beta(e|l_1 = \bar{l})\Big)\, de > \frac{a_b\bar{l}}{\delta(u_0 + a_b\bar{l})}$$

Equation (9) states the general condition for a low corruption choice for an arbitrary density function $h(\cdot)$ of shocks s. For the case of uniformly distributed prior beliefs α and uniformly distributed shocks s this yields:

$$
\begin{aligned}
l_1 = \underline{l} \Leftrightarrow \frac{1}{2\tilde{e}}\Big(\pi(2\tilde{e}-\bar{l}) + \bar{l} - \pi(2\tilde{e}-\bar{l})\Big) &> \frac{a_b\bar{l}}{\delta(u_0 + a_b\bar{l})} \\
\Leftrightarrow \frac{1}{2\tilde{e}} &> \frac{a_b}{\delta(u_0 + a_b\bar{l})} \\
\Leftrightarrow \frac{\delta}{2}(\frac{u_0}{a_b} + \bar{l}) &> \tilde{e} \qquad (10)
\end{aligned}
$$

□

Lemma 1 states the condition for a "bad" incumbent to behave properly in the first period. The probability to do so increases in δ as this leads to a higher valuation of second period payoffs and thus gives an incentive to stay in office, and the probability to get reelected can be maximized by abstain from corruption. Clearly, increasing u_0 also has a positive impact on behaving properly in the first period, as it rises the payoff in the second period and thus the incentive to get reelected. Interestingly, rising the volume of corruption, namely $\bar{l}$ has the same effect of lowering the incentive of first period corruption, though it affects both periods. Obviously, the disadvantage from the diminished reelection probability overweighs the advantage of higher first period gains. This issue will be discussed below Corollary 1. Increasing a_b rises the willingness to engage in first period corruption, as it increases immediate gains from corruption more than future gains, which has to be discounted by δ and the probability of getting reelected. The probability of first period corruption is also increasing in $\tilde{e}$, as it rises the right hand side of (10).

Proposition 3 *For fixed $\bar{l}, a_b$ and δ, there exists a $\overline{u}_0$ s.t. $u_0 > \overline{u}_0 \Rightarrow l_1 = 0$ for* all *θ in equilibrium, and $\overline{u}_0 = a_b(\frac{2\tilde{e}}{\delta} - \bar{l})$.*

Proof

Rewriting (10) leads to

$$u_0 > a_b(\frac{2\tilde{e}}{\delta} - \bar{l})$$

thus

$$\overline{u}_0 = a_b(\frac{2\tilde{e}}{\delta} - \bar{l}). \qquad (11)$$

Therefore and because $l_1 = 0$ for $\theta(I) = g$, $l_1 = 0$ for sure if and only if $u_0 > \overline{u}_0$, other things held constant.

□

Proposition 3 is a side result of the model and basically states that the amount of first period corruption is decreasing in the benefits or "wages" of being in office. This argument that officers are less in need for income from non-legal activities when they are sufficiently payed is often found in the officials and politicians salary discussion. $\overline{u}_0$ is the higher the more impatient politicians are, because then they increasingly prefer immediate gains from corruption to future gains from salary.

If we think of non-linear per period utility functions of politicians, the salary needs to be lower for higher concavity of the utility function, because politicians then might want to smoothen their income over periods and therefore more likely abstain from corruption in period 1. Note that this effect is affected by saving possibilities. If politicians are able to transfer wealth to the 2nd period, the critical salary rises because the dependency on constant income is falling. This plays an important role when thinking about non-democratic countries. The politician gets additional disciplined by the threat of revolution if this threat includes a risk of loosing some saved money (because it is fixed in assets, land, and so on, which can be expropriated in case of a revolution), hence the lower a politician's possibilities to save money in a secure way, the less he will risk to induce a rebellion by behaving too corrupt.

Corollary 1 *For fixed a_b and δ, the critical* "wage" $\overline{u}_0$ *decreases in the size of $\bar{l}$.*

Proof

trivial.

□

Corollary 1 appears rather counterintuitive at a first glance. Analogous to the phenomenon discussed in Lemma 1, it makes the assertion that, other things held constant, the critical salary to prevent the politician from getting into corruption decreases when the volume of potential corruptive activities increases. This is because an increase of volume of corruption leads both to a higher risk of getting identified as being the corrupt type and loosing second period gains, and to a higher volume of second period benefits, making it more desirable to win elections in period 1. Therefore if the volume of corruption rises, the incumbent has increasing motivation to behave properly in period 1 to preserve his chances to get reelected and to extract the increasing second period benefits when corruption is riskless. However this only holds true if the politician has to decide between $\underline{l}$ and $\bar{l}$ in a discrete manner as in our model.

An even more interesting fact is that equation (11) contains the variance of economic output, which brings us to our main proposition, stating the negative correlation between output stability and the expected level of corruption within an economy. For this, we consider a world where the gains for "bad" politicians, a_b, potential corruption volume $\bar{l}$ and base utility u_0 are different for different economies. More precisely we assume, that the u_0 for each country is drawn out of a distribution that assigns a positive probability mass to the range $[a_b(\frac{2\underline{e}}{\delta} - \bar{l}); a_b(\frac{2\overline{e}}{\delta} - \bar{l})]$.[7] Now we can state

Proposition 4 *Expected total corruption is monotonically decreasing in output stability.*

PROOF

Because *"good"* politicians always choose $l_1 = l_2 = \underline{l}$ and *"bad"* ones always $l_2 = \bar{l}$, we can focus on the first period decisions of incumbents with $\theta(I) = b$ and compare them for low and high variance of e:
Clearly, $\overline{u}_0(\overline{e}) > \overline{u}_0(\underline{e})$ for $\overline{e} > \underline{e}$, thus there exists a range $[\overline{u}_0(\underline{e}); \overline{u}_0(\overline{e})]$ with $|[\overline{u}_0(\underline{e}); \overline{u}_0(\overline{e})]| > 0$, s.t. for $u_0 \in [\overline{u}_0(\underline{e}); \overline{u}_0(\overline{e})]$ the *"bad"* politician chooses $l_1 = 0$ if $\tilde{e} = \underline{e}$ and $l_1 = \bar{l}$ if $\tilde{e} = \overline{e}$.
As we assumed a positive probability for $u_0 \in [\overline{u}_0(\underline{e}); \overline{u}_0(\overline{e})]$, the probability that $u_0 < \overline{u}_0$ (i.e. high first-period corruption) is lower for the more stable economy. Second-period corruption stays unaffected, hence expected overall corruption decreases monotonically in output stability. [8]

Stated differently, with randomly chosen variables, equation (10) is more likely to be satisfied if $\tilde{e} = \underline{e}$ than if $\tilde{e} = \overline{e}$.

□

Proposition 4 states our main thesis, i.e. high variance amplifies corruption and thus the channel between economic stability and corruption does not only work from corruption to stability but also from stability to corruption. The intuition for this is that it is easier for politicians to hide their dubious affairs away in the rather uncertain environment of an unstable economy than in the more deterministic case of a stable economy.

For a cross country comparison as in the next chapter, this means that the parameter space that leads to high corruption is larger for countries with low economic stability. Thus if one assumes that parameters are different between countries (e.g. u_0 or $\bar{l}$ differs from country to country), one should expect a negative correlation between output stability and corruption when observing a larger number of countries.

[7] This means there are cases where a given u_0 would suffice to deter politicians from corruption in a stable economy ($\tilde{e} = \underline{e}$), but not in an unstable one ($\tilde{e} = \overline{e}$).

[8] if we would allow for a choice of l_1 out of a continuous set, a bad incumbent would always choose his *optimal* level of corruption and the proposition would strengthen to *strict* monotonicity.

3 Cross Country Study

Of course our model does not prove nor wants to proof that variance of economic output is the *only* source of corruption. Nevertheless we want to look at some empirical evidence confirming our view that it is plausible to think about instability as one reason for amplifying corruption.

We therefore set up some basic regression models to find the corresponding correlations. Note that we are not able to include a full fedged empirical analysis in this section, but we rather want to find some indications for the correctness of our theoretical findings. A more comprehensive breakdown of this issue is left for future research.

One of the problems when running a cross country regression concerning corruption is the measurability of corruption. Due to the partly subjective and secret character of corruption there is hardly any exact measure of corruption for a given country. Until the mid-1990s most empirical findings concerning corruption were of a mere anecdotal nature and cross country comparisons were speculative and theoretical. Corruption was even cited as a classic example of a phenomenon that was observable but not quantifiable. But later the empirical research on corruption grew significantly because of increasing international public and private interest in determining and curbing corruption. Today, most major surveys use polls to obtain their data. This means that some personal perception is retained in the data. But for large numbers of observations the broad picture should at least give a somewhat realistic impression of the level of corruption in a country.

There are a number of different country risk surveys including ratings of corruption in there analysis. One is the Index of *Business International* (BI), a private firm now integrated in the *Economist Intelligence Unit* (EIU). It ranked countries on a range from 1 to 10 in the years 1980-1983 and is used for example by (Mauro 1995). Another index using a notion of corruption is the "Civil Rights Index" of *Freedom House*. It uses a criterium called "Free of Corruption" and provides data for 192 counties, nevertheless it is problematic to isolate the actual influence of the corruption criterium on this index value.

Probably the most famous source which tries to rank countries according to their level of corruption is the Corruption Perception Index (CPI) of *Transparency International*, which is published yearly in a global corruption report (Transparency International 2003). Basically it is a survey that subsumes a larger number of cross country polls, most of which reflect the opinion of people working for multinational firms and institutions. The original polls are carried out by NGOs as well as private institutions.[9] Thus, they capture the degree of corruption from a mostly western (but also pretty homogenous) point of view. The CPI assigns a score between 10 (no corruption) to 0 (severe corruption) to each country. In our research we use the CPI of 2003 because it seems

[9] For a comprehensive list of the composition of the CPI, see (Transparency International 2003).

to provide the most independent and unbiased measure of corruption and is freely available to the public. Also it benefits from high correlation to most of the other corruption indices and includes many of them in its composition.[10]

In order to check for the results of our model we ran some regression models to match the variance of a countries GDP per capita growth with its CPI value. The variance in GDP per capita growth is calculated from the cross country GDP values from the Penn World Table (2001) for the time horizon of 20 years (1981-2000).[11]

To illustrate the correlation between GDP growth variance and the CPI without regard of the underlying causality, we first ran a simple OLS regression (model (1)) with the CPI as the dependent variable and only the standard deviation of growth on the explaining side:

$$CPI = \alpha_1 + \alpha_2 \sigma \qquad (12)$$

where σ denotes the standard deviation of GDP per capita growth over the given time horizon.
Graphically the correlation is depicted in figure 1, with the bold line being the linear trend line of the correlation. Its slope is the highly significant coefficient from table 1 and suggests a negative correlation between CPI and σ as a stylized fact.[12]

To get a better understanding of the causality and the impact of σ on CPI, we set up some larger models. First we specify model (2), which includes some of the most common explaining variables on corruption additional to σ. Therefore we include the drift d of the GDP growth rate, the democracy level of 1995 $dem95$, the investment level *inv* as a percentage of GDP, the variable *school* as the percentage of age 15+ population in secondary school and the variable *ethno* that describes the ethnolinguistic fractionalization of a country. d is derived from our GDP data, $dem95$ takes values from 0 to 1 (1 being very democratic) and is taken from (Barro 1999) to control for democratization of the countries. *inv* is from the Penn World Table and *school* is computed from the updated (Barro and Lee 2000) dataset on education, both averages from 1980-2000. Additionally we include the variable *protestant* as the percentage of protestants in a society, the variable *import* denoting the openness to trade i.e. the goods and services imported as a percentage of GDP, the dummy variables $formerUK$ (former British colony or UK) and $federal$ (federal constitution). Finally we include the variable *absgovwage* as the absolute wage of central government members in 1990 US-Dollars. *protestant*, *import*, $formerUK$ and $federal$ are found to explain a large amount of corruption in

[10] A table of correlation coefficients between the CPI and other corruption indices is given in (Transparency International 2003).

[11] Stability seems to be a somewhat persistent phenomenon as calculations with other time horizons (10, 30) years led to similar results.

[12] Remember that *high* CPI-values indicate *low* corruption.

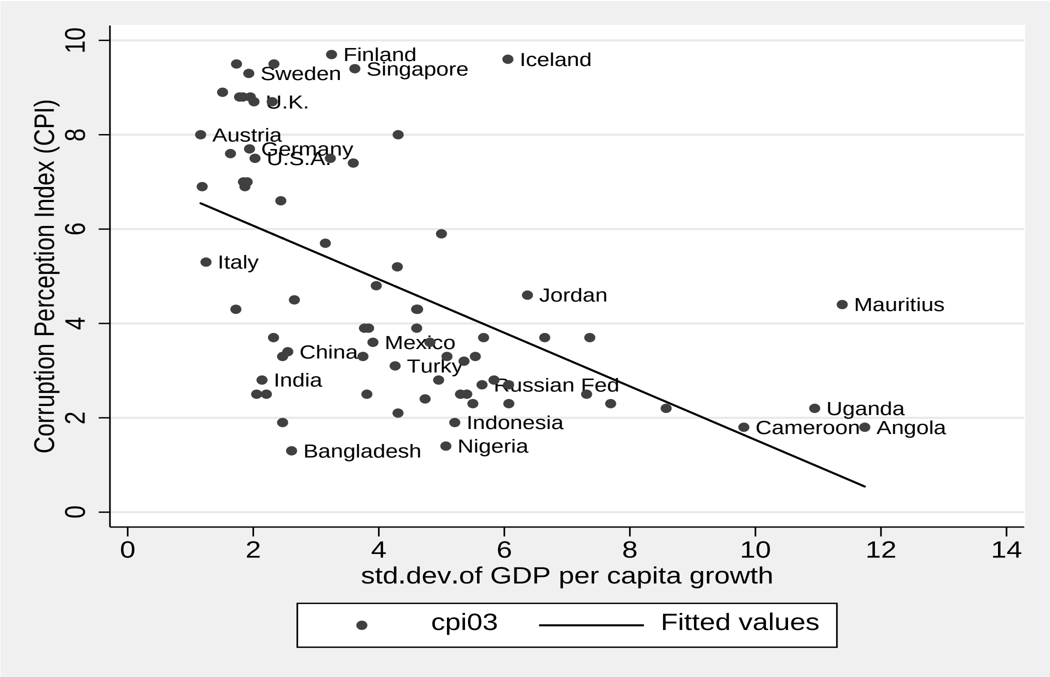

Figure 1: Negative correlation between standard deviation of economic output and CPI in a simple regression

the models of Treisman (2000). *absgovwage* is included because of its relation to our theory and is derived from Treisman's data on relative income of central government members to GDP per capita which in turn is taken from (Schiavo-Campo, de Tommaso and Mukherjee 1997). [13] The coefficients can be found under model (2) in table 1.

Model (2) seems to explain the CPI very good, with an adjusted $R^2 = 0.8071$.[14] Note that we use percentage changes in GDP to calculate the variance and therefore the standard deviation $\sigma = \sqrt{var(\Delta GDP)}$ is normalized. For low σ, the economy evolved in a relatively *"stable"* way over the last 20 years, whereas high values of σ indicate an economy with large short term deviations from the long term drift in economic output growth, hence an *"unstable"* economy in our definition.

The correlation between CPI and σ is negative as expected and the *t*-

[13]We do not explicitly enter the absolute level of per capita GDP into the regression as it turns out that it is highly correlated with the other explaining variables in this regression. In fact, absolute GDP per capita can be explained by the other independent variables of model (2) with an $R^2 = 0.81$. If we nevertheless include absolute GPD per capita and use robust estimation to correct for collinearity, σ still stays significant at the 5%-level. The same holds true for all following regression models.

[14]We are aware of the boudedness of our dependent variable, however, as the range is from 1-10, we still use an OLS model.

Table 1: Results of OLS regressions

dependent variable: CPI					
Variable	(1)	(2)	(3)	(4)	(5)
# of obs.	75	50	62	51	49
σ	-0.5674*** (0.1069)	-0.2614** (0.1142)	-0.2200*** (0.0801)	-0.1946** (0.0805)	-0.4647*** (0.1526)
d		0.1261 (0.0896)			
dem95		1.7283** (0.6906)	2.0167*** (0.6136)	1.6983** (0.6784)	1.5532*** (0.7686)
inv		0.0222 (0.0349)			
school		0.0171 (0.0213)	0.0649*** (0.0133)	0.0410** (0.0169)	0.0340* (0.0178)
ethno		-0.0124 (0.0081)			
protestant		0.0364*** (0.0085)	0.0306*** (0.0069)	0.0311*** (0.0078)	0.0287*** (0.0079)
formerUK		0.7193* (0.4230)			
import		0.0223** (0.0091)	0.0342*** (0.0071)	0.0290*** (0.0076)	0.0280*** (0.0075)
federal		0.2433 (0.4779)			
absgovwage		0.0436** (0.0166)		0.0486*** (0.0155)	0.0355** (0.0168)
constant		1.3895 (0.9369)	0.6414 (0.7143)	0.6248 (0.7007)	2.4281
R^2	0.2784	0.8472	0.7878	0.8279	0.8418
adj. R^2	0.2685	0.8030	0.7688	0.8045	0.8192

Model (5) uses predictions $\hat{\sigma}$ from the instrumental regression instead of actual σ-values. *** denotes significance at the 1%-level, ** denotes significance at the 5%-level, * denotes significance at the 10%-level. Standard errors are given in parenthesis.

value indicates a result significant at the 5% level. In model (2) even under consideration of the many other explanatory variables, σ still has a considerable impact on CPI. Take for example Cameroon, Uganda and Angola, which can be found on places 73, 72 and 67 out of 75 regarding the level of corruption and on places 72, 73 and 75 regarding stability. According to model (2) a reduction of their σ to lets say the level of Thailand would increase their CPI level by 1.39, 1.73 and 1.96 respectively corresponding to positions 49, 37 and 40 among the countries under consideration.

Interesting is the fact that the drift d in growth rates does not have any significant impact on corruption in model (2), whereas often it is suggested in the literature that high growth would decrease corruption. Also, including the absolute volume of GDP per capita does not display a significant coefficient thus the richness of a countries inhabitants does only play a minor role in explaining corruption in this model.

Next we reduce model (2) to all significant variables to check whether the impact of σ stays unchanged. We set up two new models (3) and (4), both containing σ, $dem95$, *school*, *protestant*, and *import* as explaining variables and model (4) additionally containing *absgovwage*. *School* is included as it turns out to be the only variable which is highly correlated with *absgovwage* and which changes its t-value drastically if *absgovwage* is excluded from model (2).[15]
The reduced models show that the coefficients of σ stay pretty much unchanged whereas its significance is even rising close to the 1%-level, indicating that the underlying relationship is not negligible. Note that for model (4) it was even possible to increase the adjusted R^2 to 0.8045. Controlling models (2), (3) and (4) for heteroscedasticity by deriving robust standard errors using a White correction does not change the significance levels of any of the explaining variables.

This results are encouraging, still it is not easy to show the direction of the causality between σ and CPI. To test for that, one would need appropriate instruments for σ. We tried to explain σ by the investment level *inv* and dummies for intermediate and OECD countries, *inter* and $OECD$. These three can explain σ with an adjusted R^2 of 0.4153.[16]

Using predictions of $\hat{\sigma}$ in model (4) leads to model (5) where the coefficient of $\hat{\sigma}$ changes considerably compared to the use of non-instrumented values of σ but at least it stays significant at the 1%-level. As in any empirical research on corruption with its many interacting factors it is still not easy to entirely reject the hypotheses that CPI affects σ and not the other way round. Nevertheless we argue that a high level of corruption might well have a negative impact on the *volume* of growth in GDP but we do not see many reasons why it

[15] In fact, *school* gets significant at the 5%-level if *absgovwage* is excluded from model (2).

[16] We also tried to use normalized terms of trade variance as taken from the World Development Indicators (2002) as an instrument for σ, but it turns out that - with a $\rho = 0.07$ - this variable is not sufficiently correlated to σ.

should increase the *variance* of growth in GDP, especially as it turns out that corruption levels do not change quickly over time for the most countries. Additional support for this point of view comes from Easterly, Kremer, Pritchett and Summers (1993). They show in their paper that much variation in growth rates is due to random shocks and not connected to country characteristics. Their empirical results are supported by the finding that country characteristics (and also corruption levels) are strongly autocorrelated and very persistent whereas growth rates are not. Therefore it seems much more plausible that σ is the independent variable and not CPI and we stick to our theory that the causality of the significant relation between CPI and σ works from σ to CPI and not in the other direction.

Another way to check for causality would be the analysis of global recessions or phases of high worldwide growth variance and their impact on corruption. Higher overall variance in growth should lead to higher mean levels of corruption according to our theory. Unfortunately time series for corruption data are hardly available, partly because the quantification of corruption is a relatively new concept, and partly because the methods of compiling the indices are changing over time.[17] Also, different measures of corruption can not be compared, because of the blurry nature of corruption definitions. Thus we had to abandon the idea of doing an additional time series analysis with respect to global recessions.

As said above, we expect our model to work best for democratic societies where the people have the best means to punish politicians for opportunistic behavior. Therefore we ran two additional regressions based on model (4). Model (6) is similar to model (4) but uses only "democratic" countries, model (7) uses only "non-democratic" countries. Again, it is not too easy to find a reliable variable for the level of democratization of a country, as many countries call themselves democratic or even run elections, that are definitely non-democratic from an objective point of view. For our study we follow Barro (1999) and refer to the indicator of political rights compiled by Gastil (1991) and followers. Originally, Gastil classified each country from 1 (highest level of political rights) to 7 (lowest level). We use the transformed data of Barro[18], where 1 denotes the highest level of political rights, and 0 the lowest. Countries with a democracy index higher than 0.8 in 1995 (45 out of 75 observations) are classified as democratic, others as non-democratic. The results (along with the repeated results of model (4)) are shown in table 2.[19] The σ-coefficient is only significant for democratic countries and plays a minor role for non-democratic countries, confirming our theory. In contrast, *school*, *import* and *absgovwage* are only significant for non democratic countries, indicating that

[17]Transparency International for example explicitly warns not to use its CPI reports as time series as the survey method and the sample changed many times.

[18]which we already included in model (2)

[19]Robust errors are used to control for multicollinearity.

Table 2: Results of OLS regressions, differentiating between democratic and non-democratic countries

dependent variable: CPI					
Variable	(4)	(6)	(7)	(8)	(9)
# of obs.	51	31	20	45	30
σ	-0.1946** (0.0805)	-0.2678*** (0.0722)	-0.0311 (0.0491)	-0.6672*** (0.1209)	-0.1474 (0.1494)
d					
dem95	1.6983** (0.6784)	9.7613* (5.1402)	0.2614 (0.7303)		
inv					
school	0.0410** (0.0169)	0.0285 (0.0232)	0.0427** (0.0152)		
ethno					
protestant	0.0311*** (0.0078)	0.0270*** (0.0078)	-0.0095 (0.0192)		
formerUK					
import	0.0290*** (0.0076)	0.0200 (0.0138)	0.0303*** (0.0080)		
federal					
absgovwage	0.0486*** (0.0155)	0.0367 (0.0254)	0.0509** (0.0234)		
constant	0.6248 (0.7007)	-5.5768 (4.6524)	0.5810 (0.5847)	8.3772*** (0.5473)	4.0267*** (0.7814)
R^2	0.8279	0.7656	0.8830	0.4143	0.0336
adj. R^2	0.8045			0.4007	-0.0010

*** denotes significance at the 1%-level, ** denotes significance at the 5%-level, * denotes significance at the 10%-level. Standard errors are given in parenthesis.

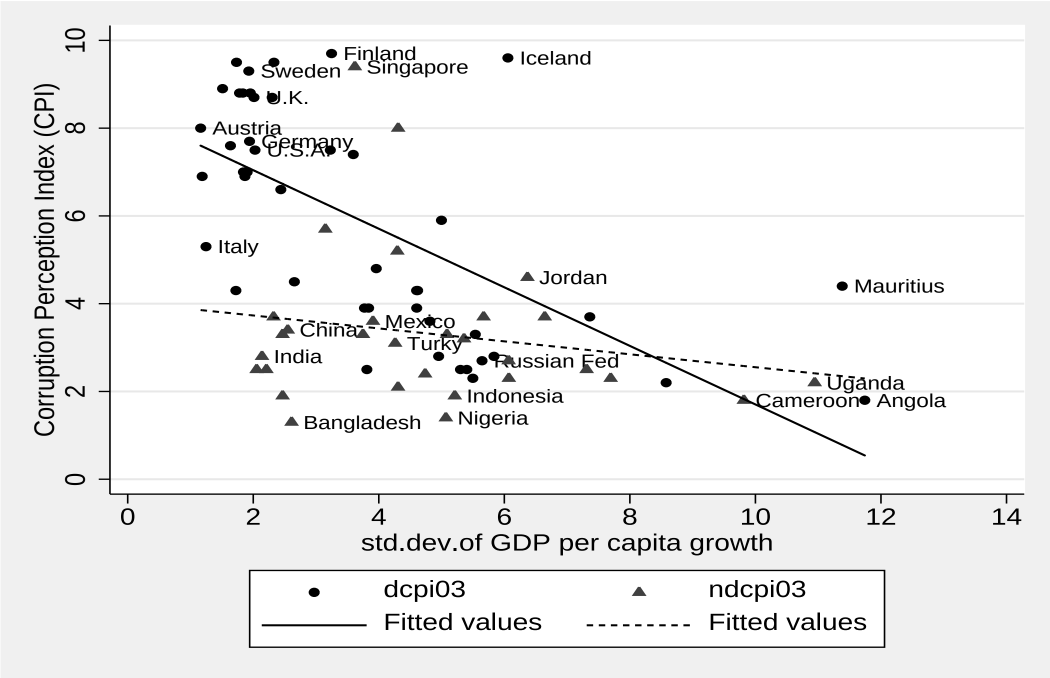

Figure 2: Negative correlation between standard deviation of economic output and CPI, differentiated for democratic *(dcpi03)* and non-democratic *(ndcpi03)* countries

these variables play a minor role for the accruement of corruption in democratic countries.

To give a graphical representation, we ran two simple regressions as in model (1), for democratic and non-democratic countries respectively. Results (denoted by (8) for democratic and (9) for non-democratic) are shown in table 2. In the simple regression, the σ-coefficient is, as expected, only significant for democratic countries. For them this simple model yields an R^2 of 0.4143. For non-democratic countries, the σ-coefficient is insignificant and the R^2 is pretty close to zero. In figure 2, the CPI of both democratic and non-democratic countries is plotted against σ additional to the linear trend line of each group.

4 Conclusion

In our model we have shown that the possibility for extended corrupt activities of politicians should be higher in countries with an unstable economic output and that remuneration, risk-aversion and the level of control exercised by the voters play important roles in determining the incentives to engage in corruption. Therefore we should on average expect a higher level of corruption in countries with a high variance in economic output. Even though the data confirms our theoretical findings as standard deviation has a significant and non-neglible coefficient in all relevant regression models, one should think about other possible explanations for these results. An alternative explanation would be that in unstable economies politicians are more afraid of future stability and development because of a higher risk of institutional crisis in this case, therefore discounting the future with a lower δ, which in turn would lead to a more myopic behavior of "bad" politicians and hence to a higher degree of corruption. At least, this interpretation would be consistent with the model presented as can be seen from equation 9.

To finally rule out other explanations, an extension of the model would be necessary. One possible addition to the theoretical model could be endogenization of economic growth by explicitly modelling the interaction between the level of corruption and the amount of investments in a economy as it is highlighted for example by Alesina and Perotti in (1996).

On the other hand we think that our simple model and the additional empirical findings could at least give an interesting impulse for thinking not only about corruption affecting the path of economic output but also to take into account the characteristics of economic output paths as one *source* of corruption itself.

Technical Appendix

In the technical appendix we want to vary the model in so far as we replace the uniform output distribution by a normal one, such that $e \sim N(\mu, \sigma)$. In our opinion this has three advantages:

1. A normally distributed output seems to be more realistic than the quite unnatural edge knifed uniform distribution.
2. Voters' beliefs can be derived for every outcome e.
3. There are no regions where citizens can infer the type of the incumbent with certainty from observing e, hence there is no *perfect* learning.

The stability of the economy is then expressed by the standard deviation σ and the drift by μ. Citizens form beliefs according to equation (6) but the probabilities now stem from the Gaussian density function for normally distributed random variables

$$f_{l,\tilde{e}}(e) = \frac{1}{\tilde{e}\sqrt{2\pi}} e^{-\frac{(e-d-l)^2}{2\sigma^2}} \tag{13}$$

where l can be $\underline{l}$ or $\bar{l}$ depending on the choice of the incumbent. So there are two possible distributions of economic outcome, depicted in figure 3.
For the equilibrium choice of I this leads to the two conditions

$$\int_{-\infty}^{+\infty} \frac{f_{\underline{l},\tilde{e}}(e)(f_{\underline{l},\tilde{e}}(e) - f_{\bar{l},\tilde{e}}(e))}{f_{\underline{l},\tilde{e}}(e) + f_{\bar{l},\tilde{e}}(e)} \, de > \frac{a_b \bar{l}}{\delta(u_0 + a_b \bar{l})} \tag{14}$$

for $\tilde{e} = \underline{e}$ and $\tilde{e} = \bar{e}$, respectively, and $f(\cdot)$ being the distributions with the gaussian form of equation 13.
To proof proposition 4 with normal distributed density functions, one has to compare the left hand sides of equation 14 for $\tilde{e} = \underline{e}$ and $\tilde{e} = \bar{e}$. If the left hand side of (14) is smaller for $\tilde{e} = \bar{e}$ than for $\tilde{e} = \underline{e}$, the proof would go through.

Unfortunately we are running into mathematical difficulties at this point, because there does not exist any closed form solution for the integral in equation 14. Until now we did not even find any qualitative statement on comparison between two integrals of this type with different standard deviation values in the gaussian functions.
One way to approach this problem is by numerical integration. At least there exists some quite efficient algorithms for that, and we did many sample calculations which confirmed our guess that proposition 4 holds true even with norm distributed shocks.

But also a proof for the validity of 4 can be given when looking at the behavior of the components in equation 14 :

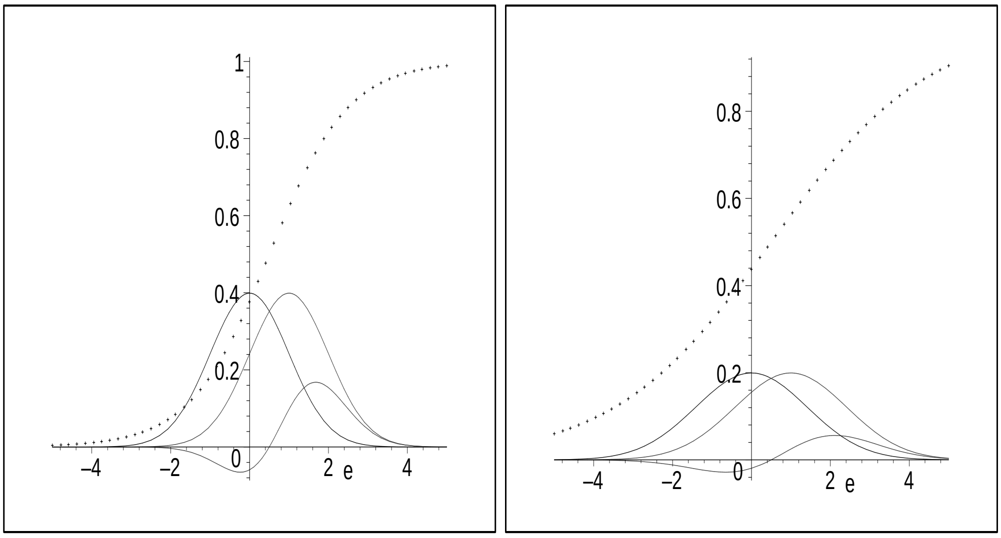

Figure 3: Output levels for low and high variance

The integral in equation 14 consists of the citizens belief $\beta_I(e)$ and the probability $p(x = e|l = l_1)$ that output e occurs when I chose l_1 and the standard deviation of shock s is $\tilde{e}$. Thus, the integrand in (14) can also be written as

$$\frac{f_{\underline{l},\tilde{e}}(e)}{f_{\underline{l},\tilde{e}}(e) + f_{\bar{l},\tilde{e}}(e)} \cdot (f_{\underline{l},\tilde{e}}(e) - f_{\bar{l},\tilde{e}}(e)) \tag{15}$$

The first factor of expression (15) is citizens' beliefs when observing e and the second factor is the difference between the probabilities that this outcome occurs when the choice is $l_1 = \underline{l}$ or $l_1 = \bar{l}$.

When looking at figure 3, things get clear quickly:
The first factor is the doted sigmoid-shaped line at the top, citizens' beliefs $\beta_I(e)$.
The second factor is the difference between the right Gaussian curve ($l_1 = 0$) and the left one ($l_1 = \bar{l}$). Thus expression (15) gives us the marginal contribution to the integral for every e, depicted by the s-shaped light line around the abscissa.

Therefore the integral value we are searching is the integral over this s-shaped function. The areas between the Gaussian curves on the left and on the right of their intersection have the same absolute value, but their contribution to the searched integral is negative on the left side and positive on the right side.
Because the beliefs-curve is upward sloping and always has the value 0.5 for the e^* where the gaussian curves intersect, the integral is positive in any case because positive contributions right of e^* are weighted with an higher $\beta_I(e)$ than negative ones left of e^*.

Now comparing for two different σ (a small σ in the left picture of figure 3 and a bigger one on the right side) yields a *"flatter"* curve $\beta_I(e)$, leading to a smaller difference between positive and negative contributions to the integral, and therefore to a lower positive integral value.[20]
This shows us that the condition for the choice of high corruption changes with the variance of output even in the normally distributed case and therefore a modified proposition 4 holds true for this case as well .

□

[20]In the extreme case of $\sigma \to \infty$ the $\beta_I(e)$ curve gets horizontal and the integral value of equation (14) converges to 0, meaning that there would be no chance for learning in this case. On the other hand, the simplified case with a discrete distribution of e leads to a step function instead of the former sigmoid and opens the possibility for perfect learning.

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