THE CORRUPTION GAME

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ABSTRACT

This thesis provides a new framework to analyze corruption. Corruption is defined, here, as a deviation from cooperative equilibrium in order to gain advantage over other players. It is shown that corruption can lead to an increase in efficiency under certain conditions when there is over taxation by the regulator and when a contribution to the common pool can be enforced to certain extent. However, generally, corruption decreases overall efficiency, and increases inequality. The effect of abundance in natural resources and economic uncertainty is also analyzed.

To the memory of Elmar Huseynov

"That which is common to the greatest number has the least care bestowed upon it".

Aristotle

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INTRODUCTION

During the past 50 years a few influential papers about corruption have been written. Early papers were primarily theoretical principal agent models where different ways of coping with corruption were analyzed. Beginning from 1990 a new bunch of empirical papers emerged. These papers showed the negative relationship between corruption and growth. Also, few theoretical papers analyzed the mechanism how corruption effects economic activity.

While early authors like Nathaniel Leff (1964) and Samuel P. Huntington (1968) point to possible positive effects of corruption, nowadays it is largely accepted wisdom that corruption has detrimental effect on economic performance. Some empirical papers like Paolo Mauro (1995) reveal the negative association between corruption and economic performance primarily through negative effect on private investment. Also, Mauro (1995) shows that corruption in highly bureaucratic country is equally devastating for economy as in country with low level of bureaucracy. According to the author this contradicts the argument that corruption can serve as speed money in highly bureaucratic society.

Andrei Shleifer and Robert W. Vishny (1993) attribute corruption's negative effect to its secrecy. They also draw attention to the effect of centralization/decentralization on the level of corruption. They argue that in decentralized economy there is more corruption due to complementarity. When there are several complementary permits necessary to do business and these are distributed by several uncoordinated bureaucrats there will be more corruption.

Daron Acemoglu and Thierry Verdier (2000) model general equilibrium economy with corruption. In this economy the government intervenes to correct for externalities; however this, in turn, creates opportunity for corruption. There is a trade off between correcting for market failures and corruption. The authors show that under certain assumptions there can be equilibrium with some corruption.

There is also a large number of empirical works written by the IMF staff that points to the effects of corruption on different aspects of economy. These studies show the negative effect of corruption on health, education, tax revenue, public infrastructure and etc.

All the papers written on corruption see the solution to the problem in better control of bureaucrats. This approach is consistent with the definition of corruption used by these authors. Corruption, in conventional literature, is defined as the use of public office for private gains. Several solutions like efficiency wages to public officers, better control of bureaucrats, enhanced accounting and etc are proposed to fight with corruption.

In this work I will propose an alternative view to corruption problem. I will focus on incentives for private agents in the "corruption game". Unlike in corruption literature I will not study the problem from only the bureaucrats' side, but rather focus on private incentives in paying corruption. This approach can shed light on certain aspects of the problem that can not be understood otherwise. It is probably true that the reality lies somewhere between these two approaches. That is why I later include bureaucrats to the model. I do not make any assumptions about government's objective. In the model I consider, even the regulator which is not benevolent will be interested that agents do not fully evade taxes.

Before starting to analyze the specificities of this approach it would be useful to define corruption. I strongly agree with Acemoglu and Verdier (2000) that corruption is a result of government intervention to correct for market failures. In order to increase overall efficiency government intervenes to economy. This intervention can be justified in view of public goods and/or externalities. Acemoglu and Verdier (2000) model economy with pollution externalities. This approach is reasonable however I think that a more encompassing description of government intervention would be in terms of non excludible public good. This approach is not limited to material public goods. Think about rules, regulations and laws. They restrict individuals so as to increase overall efficiency. For example, one can think of driving regulations. Individuals restrict themselves by complying with certain rules in order to increase overall efficiency. However, not all rules are optimal and this case is considered in the model. This compliance can be thought as contribution to public good. Thus, rules are taxes imposed on individuals. Corruption makes it possible to circumvent rules. An individual has an incentive to deviate while others cooperate. However, since everybody thinks like this and deviates we are back to no rule case. This outcome can be even worth than no rule case. Because agents pay bribes in addition to negative externalities. Of course the benefits from corruption also accrue to some small number of individuals who are responsible for enforcement of rules. It has to be seen which effect outweighs the other.

The same logic can be applied in the economic context. Agents in an economy will also have an incentive to deviate from cooperative equilibrium given that others cooperate. However this means that, under certain plausible conditions, every individual will deviate and as a result there will be no solution to externality problem. Thus corruption can lead to inefficiency. Economy stays at *Pareto inferior* equilibrium. Society can not reach it is goal of increasing efficiency due to the offsetting effect of corruption. This view is different than in corruption literature. However, it is possible to draw some parallels. Shleifer and Vishny (1993) point out that one of the reasons that corruption is bad is in its secrecy. Secrecy makes corruption more distortion because bureaucrats will switch to projects that are less probably detected. In my framework secrecy is bad because the market failure can not be corrected.

It is important to distinguish between two types of corruption as mentioned in literature. There is corruption when bureaucrats steal money on certain projects. This kind of corruption fits the definition in conventional literature. Also, there is corruption where bureaucrat is bribed by private agent. Without loss of generality, the framework provided in this paper includes both. When bureaucrat steals money he also deviates from social cooperation. Another reason in support of framework used in this work is corruption in private sector. The conventional definition restricts corruption to government sector. What about corruption in private companies among managers and shareholders, in private universities etc.? In all these cases agents agree to cooperate in order to increase joint efficiency. There is no government official; there are just rules that everybody should obey.

The no corruption equilibrium in this framework is sustainable only if we consider the repeated games approach. No corruption equilibrium will be sustainable if the benefit from cooperation and discount rate are high enough. This is standard approach used in industrial organization. No corruption equilibrium can also be sustained if the regulator can enforce full compliance to taxes. This is unlikely to happen and means that the bureaucrats have no discretionary power. In my model I will consider the case when the regulator can enforce partial contribution to the public good. The problem is that if all agents are same and regulator knows this how is it possible that some evade taxes? The answer is that the regulator is also an agent who has utility function like others. By allowing bribes he/she simply tries to maximize his personal utility. I do not make any assumptions whether regulator is benevolent or not he has some utility function and behaves according to it.

After analyzing this I will switch to corruption in transition economies and poor countries. The main difference in most transition countries is economic uncertainty and political instability. If these factors are applied to the repeated games model it can be seen that no corruption equilibrium can no longer be sustained. Agents will place some probability that they will not be in game next period. Thus, agents play one shot game when this probability goes to zero. Agents do not care about future and thus prefer to pay corruption. Short term game is valued more than long term game. The high correlation between political instability and corruption is mentioned in Mauro (1995). However there is no answer why this is the case. I think the framework provided in this work can explain to some extent why there is huge difference in corruption levels among different countries. The effects of natural resources and public good that depreciate gradually on the likelihood of cooperation are also considered.

I will also consider whether it is possible that corruption increases efficiency. The answer is positive. However, this is the case only under certain conditions. It will be shown that under command economy corruption can really increase efficiency. The necessary conditions for this are over taxation and enforceability of compliance to certain extent.

In the first part I do not consider bureaucrats. I assume that the benefits from corruption go to very small group of population which is not interesting for welfare implications very much. Later, I consider the case with considerable number of bureaucrats and assume that the corruption money is divided equally among these bureaucrats. It is shown that corruption increases inequality. The smaller is the number of bureaucrats the higher is inequality.

In this framework then either everybody pays bribes or nobody pays. How is it possible to think about corruption when some part of population pays? I will propose two solutions. First is to think of this repeated interaction in many markets. Then in some markets there will be full corruption in others there will be no. Another way is to incorporate asymmetric information. Since there are a huge number of agents playing this game it is impossible to see the actions of all the other agents. This means that it is possible in certain cases that only very small part of population pays bribes. The majority does not know about this. When the number of people paying bribes increases above some threshold value then everybody knows this and deviates. This is to say that there is either very small number of people who pay corruption or majority pays bribes.

One important note should be made. The framework in this paper is pertinent to societies with market economies. In command economy corruption can be justified from different aspects. I assume that like in market economies regulators goal is to intervene optimally. In command economy over intervention can make it profitable to deviate under some conditions.

I would say that in command economies corruption substitutes for lacking incentives to agents. Corruption creates shadow economy which increases incentives of agents. For example in a command economy people pay bribes to doctors, bureaucrats in order to increase their incentives to serve individual better. Since government does not allow differentiation people create these through corruption. A lot of examples could be found on this issue in command economies. People paid extra bribes to sellers in shop in order to buy fashionable clothes that were not widely available.

This kind of corruption can be said to increase efficiency. However the problem with this type of corruption is that it creates market that is secret. Thus it is impossible to correct for market failures in this market.

The type of corruption mentioned in the previous paragraph can also explain partly corruption in poor countries. If government pays very little to its bureaucrats, people will have an incentive to pay extra money to these bureaucrats in order to provide them with better incentive. Agents are over restricted and they circumvent this with bribes. In contrast, the corruption mentioned in repeated game context is different in its nature. There agents want to have an advantage over others.

CHAPTER 1: THE MODEL

I model an abstract economy with n identical agents. The utility of agents depends on public good and private good. Each agent has an endowment equal to m. I also assume an abstract regulator who decides how much each agent should contribute to public good. This abstract regulator chooses the level that satisfies jointly efficient outcome. Then I will allow for bribes. Namely, an agent might choose to pay bribes and not contribute to public good.

The utility function is defined as follows:

$$U_i = q^{\alpha} c_i^{1-\alpha} \qquad \text{or} \qquad U_i = (m\sum_{i=1}^{n} t_i)^{\alpha}(m - mt_i)^{1-\alpha}$$

which can be simplified to:

$$U_i = m(\sum t_i)^{\alpha}(1-t_i)^{1-\alpha} \tag{1}$$

In this utility function each agent derives utility both from public good and from private consumption. I assume that public good is non excludible. The utility function is concave in public and private good.

First, let us calculate symmetric Nash equilibrium level of t:

$$t^{nash} = \frac{\alpha}{1+(n-1)(1-\alpha)} \tag{2}$$

For n very large this goes to zero.

Now, the regulator chooses t to maximize joint utility:

$$\max_t \sum_{i=1}^{n} U_i$$

Since all the agents are identical we get that the value of contribution to public good under symmetric cooperative equilibrium is:

$$t^{coop} = \alpha \tag{3}$$

As it is clear $t^{nash} < t^{coop}$ for $n \geq 2$. This is well known result that is due to externalities. Since under Nash equilibrium agents do not internalize externalities there is inefficiency. The utility of each agent under jointly efficient outcome is then:

$$U_i = m(nt^{coop})^{\alpha}(1 - t^{coop})^{1-\alpha} \tag{4}$$

Now let us allow for bribes. This can be done the following way. Assume that an agent can pay bribe bm, where b is smaller than t, and not contribute to public good. Later I assume that an agent should contribute to public good at least to some extent but still can pay bribes in order not to pay the full amount of taxes. One important note is to be made about bribes. I assume that bribes all go to one agent or a very small group of agents and increase their private consumption. For the moment one can think that it is not important for the results how much utility this agent or very small group of agents derive. I allow for large number of agents who receives these benefits later. This means if bribes are allowed then assuming all others contribute except one agent then the utility of that agent is:

$$U_i = m((n-1))t^{coop})^{\alpha}(1 - b)^{1-\alpha} \tag{5}$$

As one can see for n sufficiently large this value is larger than the utility when everybody contributes. Thus, if everybody contributes it is better for one agent to pay bribes and not to contribute. The equilibrium with bribes will be mixed strategy Nash equilibrium where agents contribute with some probability.

To make things more realistic, assume that although it is possible to pay bribes and deviate there should nevertheless be some contribution to public good, incorporated exogenously to the model, by each agent.

The utility of an agent if he deviates is:

$$U_i = m((n-1))t^{coop} + t_{corr})^{\alpha}(1-b-t_{corr})^{1-\alpha} \tag{6}$$

where $b + t_{corr} < t^{coop}$. Here, t_{corr} is the amount of tax that should be contributed if the agent pays bribes. Of course, it should be less than the tax paid under full cooperation. Otherwise there is no point in paying bribes. Again for n sufficiently large for a single agent it is profitable to pay bribes and some level of taxes and deviate from cooperative equilibrium. Unlike in the case with no contribution and corruption, here in one shot game everybody deviates in equilibrium. Every agent pays bribes and contributes to some extent. In this game paying bribes strongly dominates cooperation. As a result economy is stuck in *Pareto inferior* equilibrium. Is it possible that no corruption equilibrium is sustainable? The answer is yes if we consider repeated interaction as one of the solutions. There is no deviation if:

$$\frac{1}{1-\delta}m(nt^{coop})^{\alpha}(1-t^{coop})^{1-\alpha} \geq m((n-1))t^{coop} + t_{corr})^{\alpha}(1-b-t_{corr})^{1-\alpha} + \frac{\delta}{1-\delta}(nt_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha}$$

or

$$\delta \geq \frac{((n-1)t^{coop} + t_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha} - (nt^{coop})^{\alpha}(1-t^{coop})^{1-\alpha}}{((n-1)t^{coop} + t_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha} - (nt_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha}} \tag{7}$$

As one can check for n sufficiently large when t_{corr} increase the numerator converges to zero faster than the denominator thus δ decreases which means it is less likely that the deviation from cooperation will occur.

In this framework, one can check the effect of economic uncertainty and political instability. Assume that each period there is a probability p that the agent will be in "business" next period. Then

$$p\delta \geq \frac{((n-1)t^{coop}+t_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha}-(nt^{coop})^{\alpha}(1-t^{coop})^{1-\alpha}}{((n-1)t^{coop}+t_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha}-(nt_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha}} \tag{8}$$

A decrease in p decreases the likelihood that the necessary equation for no corruption will be satisfied. This, in turn, implies that the property rights of agents should be ensured because this factor affects the nature of the game the agents will play. When an agent in abstract economy is not sure whether he will be in game next period then he will play one shot game which will make him to deviate.

In this model, one can account for the effect of abundance in natural resources. To do this, assume that even if all agents do not contribute to public good there are still some resources allocated to this purpose. By changing the model slightly I can check for the effects of this change. To get better understanding, assume that a country has large oil resources. Then the government can provide some part of public good through this channel. Let e be the amount of natural resources contributed to public good. Then, cooperation is feasible if:

$$\frac{1}{1-\delta}(nt^{coop}+e)^{\alpha}(1-t^{coop})^{1-\alpha} \geq ((n-1)t^{coop}+t_{corr}+e)^{\alpha}(1-b-t_{corr})^{1-\alpha}+\frac{\delta}{1-\delta}(e+nt_{corr})^{\alpha}(1-b-t_{corr})^{1-\alpha}$$

or

$$\delta \geq \frac{((n-1)t^{coop}+t_{corr}+e)^{\alpha}(1-b-t_{corr})^{1-\alpha}-(nt^{coop}+e)^{\alpha}(1-t^{coop})^{1-\alpha}}{((n-1)t^{coop}+t_{corr}+e)^{\alpha}(1-b-t_{corr})^{1-\alpha}-(nt_{corr}+e)^{\alpha}(1-b)^{1-\alpha}}$$

For n sufficiently large this can be simplified to:

$$\delta \geq \frac{(nt^{coop}+e)^{\alpha}}{((nt^{coop}+e)^{\alpha}-(nt_{corr}+e)^{\alpha}}\frac{((1-b-t_{corr})^{1-\alpha}-(1-t^{coop})^{1-\alpha})}{(1-b-t_{corr})^{1-\alpha}} \tag{9}$$

where the right hand side increases in e. This is because the public good function is concave. This means that when there is a large amount of natural resources it is harder to sustain no corruption equilibrium.

I will now check how the results change if some part of public good is left for future periods at constant rate of θ. For simplicity, I will ignore the part that is contributed to public good under corruption. This will not change the result and make the equation of interest simple. The condition for no corruption is .

$$\frac{1}{1-\delta}(\frac{1}{1-\theta}nt^{coop})^{\alpha}(1-t^{coop})^{1-\alpha} \geq (\frac{1}{1-\theta}((n-1)t^{coop}))^{\alpha}(1-b)^{1-\alpha} + \delta((\frac{\theta}{1-\theta}(n-1)t^{coop}))^{\alpha}(1-b)^{1-\alpha} + \delta^2((\frac{\theta^2}{1-\theta}(n-1)t^{coop})(1-b)^{1-\alpha} + \ldots$$

Simplifying we get

$$\delta \geq \frac{(1-b)^{1-\alpha} - (1-t^{coop})^{1-\alpha}}{(1-b)^{1-\alpha} - \theta(1-t^{coop})^{1-\alpha}} \qquad (10)$$

This means that as the rate of depreciation of public good goes to zero it is less likely that there will be no corruption.

CHAPTER 2: EFFICIENCY RESULTS

In this part I will analyze the efficiency results under corruption. I will consider two cases with no (very small number of) bureaucrats and with considerable size of bureaucrats.

No bureaucrat case

This case applies to the situations when the benefits from corruption go to very small amount of bureaucrats. In this case I will not include bureaucrat's utility into society utility because they comprise very small part and it is not really very interesting if this part lives very good.

First, let us consider the most interesting case when the regulator charges optimal taxes and everybody deviates. Some part of taxes is collected from everybody despite corruption. Then if everybody deviates by paying bribes one gets:

$$nm(nt_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha} \leq nm(nt^{coop})^{\alpha}(1-t^{coop})^{1-\alpha} \tag{11}$$

So the overall efficiency is lower under corruption than when the regulator interferes optimally.

Can corruption increase efficiency? According to our model it is not possible if the regulator interferes optimally. However, what happens if the regulator does not interfere optimally? What happens if the regulator overtaxes agents? The answer is that in this case under some conditions in the framework analyzed in this paper corruption can increase efficiency. This will not be the first best situation which is when the regulator taxes agents optimally but the equilibrium with corruption can be the second best given that the regulator over taxes.

Assume that the regulator sets $t^{over} > t^{coop}$. Where t^{over} is more than optimal. This can be explained with different estimates of α by regulator and private agents or by desire to collect more bribes. The case when there is corruption with no contribution is straightforward. It is worth than the case with over taxation. However, interesting results appear if one lets corruption with the contribution to public to some extent. I assume the level that can be collected from private agents is large enough. Corruption can increase efficiency compared to full compliance under taxation. In the case of over taxation one has:

$$nm(nt^{over})^{\alpha}(1-t^{over})^{1-\alpha} \tag{12}$$

Here, there is too much public good and too little private good left. This is less than the efficiency under optimal level of taxation. However, if one allows for corruption it will decrease the public good which is anyway too much and increase private good which is low. Of course, corruption will not restore full efficiency but it will increase efficiency.

Under corruption with over taxation one gets:

$$nm(nt_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha} \tag{13}$$

This can be higher than the overall utility above if t_{corr} is sufficiently high. Although this is still not the most efficient outcome, this example shows that corruption can be beneficial.

One note of caution should be made about the results with very small number of bureaucrats. Actually when there is single regulator with the same utility function as other agents it is not true that there will be full corruption. This is because this one regulator when accepting bribes will internalize externalities. To see this let us look at the equation for single bureaucrat. Let x be the number of agents that will successfully bribe bureaucrat. Then the objective function is:

$$((xt_{corr} + (n-x)t^{coop})^{\alpha}(1+xb)^{1-\alpha}$$

or

$$(nt^{coop} - x(t^{coop} - t_{corr}))^{\alpha}(1+xb)^{1-\alpha} \qquad (14)$$

This equation shows that actually bureaucrat might not be interested in accepting bribes from all agents. When deciding whether to accept bribe or not bureaucrat considers its positive effect on his private consumption and it is negative effect on his public good consumption. When additional bribe has higher cost than benefit he will not accept it. The bureaucrat will choose such x that he maximizes his utility function. That is why it is not completely true to assume that single bureaucrat will accept bribes from all agents. I circumvent this problem by assuming that bureaucrats are very greedy and value very little public good or that their utility is different and does not depend much on public good. This phenomenon does not cause problems when there are many bureaucrats which are uncoordinated. In this case, bureaucrats do not care internalize externalities that is why full corruption equilibrium emerges.

The case with bureaucrats

In the entire story that I considered above I excluded bureaucrats. Now let us consider the case when there are bureaucrats that also derive utility from private and public good and also have an endowment of m. There are d bureaucrats and n agents – a total of z people. z is fixed. The number of bureaucrats is always smaller than or equal to the number of agents. In what follows I assume that when there is corruption the benefits are distributed equally among bureaucrats. Bureaucrats are identical. I will also assume that they contribute to public good by not taking bribes. Also they have to contribute to public good to some extent. This case is considered because it is interesting. When bureaucrat and agent meet they can agree to contribute to public good only to some extent and share the gains between themselves. For convenience, I assume that they share it equally. Under full cooperation and optimal taxation the overall utility is:

$$(n+d)m((n+d)t^{coop})^{\alpha}(1-t^{coop})^{1-\alpha} \tag{15}$$

Under corruption when everybody deviates but nevertheless contributes something to public good the overall utility is

$$nm((n+d)t_{corr})^{\alpha}(1-t_{corr}-b)^{1-\alpha}+dm((n+d)t_{corr})^{\alpha}(1-t_{corr}+\frac{n}{d}b)^{1-\alpha} \tag{16}$$

If one compares this to the case above it is seen that generally under corruption with bureaucrats there is inefficiency compared to the case with no corruption. However when taxes collected under corruption are sufficiently close to taxes collected under no corruption might increase efficiency.

Another interesting result arises if I substitute $z-d$ for n, z for $n+d$ and take the derivative with respect to d. The equation above increases in d. It means for efficiency results it is better when the number of bureaucrats is relatively high. This result arises from concavity of our objective function because the marginal benefit decreases as the amount of private good increases. When there are a large number of bureaucrats this also leads to more equal distribution of gains.

CONCLUSION

The framework used in this work sheds light to some important issues about corruption. The private agent based approach used here can explain some specific features of corruption. I do not consider corruption as something that is related only to bureaucrat's discretionary power. I think about corruption as a result of private agents actions directed to deviate from optimal cooperation in order to gain some advantage. This in turn causes everybody to deviate which results in *Pareto inferior* equilibrium. The repeated nature of corruption game can solve this problem under sufficiently high discount rate and high rate of tax collection.

Several extensions are analyzed under repeated game approach. Abundance of natural resources makes agents more likely to deviate from cooperation. Uncertainty, on the other hand, changes the nature of the game .

Efficiency results show that corruption can increase efficiency if the regulator over taxes private individuals. The existence of small number of bureaucrats makes them internalize externalities and limit the incidence of corruption. However, when the number of uncoordinated bureaucrats is above some threshold it is better to have more bureaucrats So that the benefits from corruption are shared equally. Since the objective function is concave in both public and private good the efficiency is higher if many bureaucrats have small gains from corruption than if few bureaucrats have large gain.

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