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On Corruption and Capital Accumulation

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Abstract

Reforming economies have typically placed little attention on the impact of illegal activities on the success of reform/stabilization packages and optimal policy design. This paper aims at developing a framework in which to assess an economy's response to alternative stabilization/reform packages as a function of the scope of corruption activities. The framework developed herein is a basic one in which only the most fundamental questions (such as the effects of anti-corruption government policies on output and welfare) are examined. The more interesting questions of the optimal design of stabilization and economic reform policies remain to be addressed in future extensions of the model. The framework also accommodates political-economy analysis, and is able to explain why, even when able to eliminate corruption activity altogether, governments may choose not to do so. Our framework differentiates between developing and developed economies according to the income share accruing to capital, as is common in the literature. In equilibrium, the effect of anti-corruption penalties on the economy's capital stock is greater in developing countries; in particular, we find that the elasticity of the steady state average per capita stock of capital with respect to increases in anti-corruption penalties is increasing in the income share accruing to capital. The model also shows that reductions in public good output, as a fraction of the economy's total expenditure, lead to larger welfare decreases when in the presence of corruption.

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### Summary

The assertion that corruption is an observed phenomenon (or so-called stylized fact) in most--if not all--countries seems undisputed. The incidence of corruption is arguably greater in institutional settings exhibiting large and pervasive bureaucracies, deficient judicial systems, bureaucratic incompetence, ill-defined property rights, and microeconomic controls, as all give rise to complex and time-consuming procedures, that is, "red tape." Such environments constrain foreign investors, domestic producers, and consumers, who, as a result, often succumb to "illegal taxation," that is, bribery of bureaucrats in key positions, whose capacity to absorb bribes is facilitated by the above-described settings.

Reforming economies have typically focused their reform plans on fiscal deficit reductions, privatization schemes, and restoration of the price system's role in allocating resources and conveying information. Although little attention has been given thus far to the impact of illegal activities on the success of reform/stabilization packages and optimal policy design, there is a need to establish a framework in which to assess an economy's response to alternative stabilization/reform packages as a function of the scope of corruption activities. This paper aims to develop one such framework, in which only the most fundamental questions, such as the effects of government anticorruption policies on output and welfare, are examined.

This paper studies the relationship between corruption and capital accumulation using a dynamic model in which the government is assumed to observe bribe activity imperfectly. The model differentiates between developing and developed economies according to the income share accruing to capital, which is higher for developing countries.

The model provides several interesting results. For example, it shows that reductions in public good output, as a fraction of the economy's total expenditure, lead to larger welfare decreases when in the presence of corruption. Also, the framework can accommodate political-economy analysis and is able to explain why, even when it is possible to eliminate corruption activity altogether, governments may choose not to do so. Moreover, the model also predicts that the effect of anticorruption penalties on the economy's capital stock can be greater in developing countries; in particular, it finds that the elasticity of the steady state average per capita stock of capital with respect to increases in anticorruption penalties is increasing in the income share accruing to capital.



## I. Introduction

The assertion that corruption is an observed phenomenon (or so-called "stylized fact") in most countries, not to say all, seems undisputed. Corruption, understood as the illegal appropriation of resources, may be defined as "official" or "private" according to various criteria. For example, it may be defined as "official" when the orchestrators of such acts only include government officials, or as "private" when only private individuals are involved. Alternatively, "official" and "private" corruption may be defined in terms of who bears the direct costs or benefits of such acts.

The incidence of corruption is arguably greater in institutional settings exhibiting large and pervasive bureaucracies, deficient judicial systems, bureaucratic incompetence, ill-defined property rights, and microeconomic controls, all giving rise to complex and time consuming procedures, i.e., "red tape." Such environments constrain foreign investors, domestic producers, and consumers. As a result, investors, producers and consumers often succumb to "illegal taxation", i.e. bribes, by bureaucrats in key positions, whose capacity to absorb bribes is facilitated by the above described settings.

Reforming economies have typically focused their reform plans on fiscal deficit reductions, privatization schemes, and restoration of the price system's role in allocating resources and conveying information. However, little attention has been placed thus far on the impact of illegal activities on the success of reform/stabilization packages and optimal policy design. The latter underscores the need to have a framework in which to assess an economy's response to alternative stabilization/reform packages as a function of the scope of corruption activities. This paper aims at developing one such framework in which only the most fundamental questions (such as the effects of anti-corruption government policies on output and welfare) are examined. The more interesting questions of the optimal design of stabilization and economic reform policies remain to be addressed in future extensions of the model.

This paper studies the relationship between corruption and capital accumulation using a dynamic model in which the government is assumed to observe bribe activity imperfectly. The economy is populated by private agents (bureaucrats and non-bureaucrats), firms and a government. Non-bureaucrats can either consume or invest in physical capital, which earns a competitive return. Bureaucrats can either consume or invest in physical capital, or engage in bribe-taking activity, modeled as the appropriation of

a fraction of the non-bureaucrat's interest income. 1/ 2/ Bureaucrats are used in the production of a public good.

The model provides several interesting results. For example, it shows that reductions in public good output, as a fraction of the economy's total expenditure, lead to larger welfare decreases when in the presence of corruption. The framework also accommodates political-economy analysis, and is able to explain why, even when it is possible to eliminate corruption activity altogether, governments may choose not to do so.

The model differentiates between developing and developed economies according to the income share accruing to capital (higher for developing countries), a commonly used distinction in the literature (see e.g. Romer (1989, p.63)). In equilibrium, the effect of anti-corruption penalties on the economy's capital stock can be greater in developing countries; in particular, we find that the elasticity of the steady state average per capita stock of capital with respect to increases in anti-corruption penalties is increasing in the income share accruing to capital. This result follows because penalty increases lead to increases in (penalty) revenues to the government which can be used to finance higher production levels of a public good that is complement, in preferences, to the private good. Penalty increases yield higher increases in government revenues in developing countries because interest income is higher in such countries and for penalty schemes that are increasing in bribe income collected by bureaucrats.

It is important to qualify the analysis in several crucial respects. First, the model ignores (income) distributional effects of corruption across non-bureaucrats and across bureaucrats (this is so as the paper models an economy populated by the government and three representative agents-- firms, bureaucrats and non-bureaucrats). However, the model does study (distributional) effects of corruption between the (representative) bureaucrat and the (representative) non-bureaucrat.

Second, the model studies cases in which, other than for the deadweight losses associated with corruption activities, the economy exhibits no pre-

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1/ We model bribe activity as a criminal action (i.e., straight appropriation of a portion of the non-bureaucrat's interest income) on the basis of realism as typically bribe payments are made as a necessary condition for the undertaking of commercial activities. Alternatively, one could model bribe activity in an oligopolistic setting as a mechanism on the part of bureaucrats to favor individual firms by blocking activities of rival firms. In this paper, however, we pursue our analysis in a competitive setting.

2/ As corruption activity arises endogenously from the government's imperfect monitoring technology, the model lends itself to an extension in which not only bureaucratic but also non-bureaucratic corruption (e.g., tax evasion, black markets) exist. We plan to undertake such extension in future work.

existing distortions. The presence of pre-existing distortions may give way to rent-seeking behavior and strategic competition among various non-bureaucratic groups. Admitting such pre-existing second-best environments together with the implied strategic behavior for various non-bureaucratic groups is very appealing on observational grounds. However, given the additional complexity involved, such important extension remains a topic for future research. 1/

The model's formulation of the government's behavior is consistent with a wide variety of objective functions (including utilitarian, Pigovian and Rawlsian welfare functions). Specifically, as shown in Section V, the government affects the equilibrium evolution of the economy's capital stock and public good spending by the choice of penalties on corrupt activity. As presented in Sections III and IV, stationary equilibrium is solved for a given government penalty function; thus, the paper does not take a position on the government's objective (or welfare) function. The latter is left to the reader.

The paper is organized as follows. Section II develops the dynamic general equilibrium model while section III specifies the equilibrium evolution equations of the economy. Section IV determines the stationary equilibrium. Section V discusses policy implications. Section VI contains concluding remarks. Finally, for derivations and presentation of a more general model than the one used in this paper, the reader is referred to Asilis and Juan-Ramon (1993), copies of which are available upon request from the first author.

## 1. Literature review

The bulk of literature on corruption studies the phenomenon from a strictly descriptive, sociological, political or moral perspective (see e.g., Banfield (1975), De Soto (1989), Klitgaard (1988), Leff (1964), Noonan (1984), United Nations (1989)). There is, however, recent work that examines the economics underlying illicit activity (see e.g. Becker (1968), Becker and Stigler (1974), Johnson (1975), Rose-Ackerman (1975), Lui (1985), Alam (1990), and Shleifer and Vishny (1993)).

Most studies stressing the economic aspects employ the principal-agent framework to analyze the relationship between the government (principal) and the agents (bureaucrats) (see e.g., Becker (1968), Becker and Stigler (1974), Rose-Ackerman (1975), and Shleifer and Vishny (1993)). In the prototypical model of this literature, corruption emerges as agents,

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1/ Greater complexity leads one to undertake behavioral assumptions for the various non-bureaucratic strategic players--e.g. the choice among different instruments for competition (bidding for rents): prices versus quantities, for example--and the length of history dependent strategies--with the varying equilibrium concepts involved--e.g. Markov-perfect, closed-loop subgame perfect equilibrium, closed-loop renegotiation-proof equilibrium.

imperfectly monitored by the government, take bribes in the process of buying and selling goods from the private sector on behalf of the government. These studies examine, in static settings, to what extent bribery is affected by alternative sanctions or incentives, monitoring technologies, and the degree of competition among agents and private individuals (in providing government goods to the private sector and in selling privately produced goods to the government).

Becker (1968) pioneers the use of economic analysis to study corrupt activities. He questions the "optimal" amount of both resources and punishment that should be used to enforce different kinds of legislation. The answer springs from minimizing an income social loss function from offenses with respect to the policy variables, namely, the probability of apprehension and conviction (determined by the resources spent on police, courts, etc.), and the punishment (fine). The social loss function equals the sum of the net damages to society, the cost of apprehension and conviction, and costs of carrying out the punishment imposed. Becker concludes that optimal probability-punishment deters offenders at the margin; thus, crime "not paying off" (at the margin) is an optimality condition and not an implication about the efficiency of the policy or the courts. Additionally, he finds that, costs being the same, the optimal probability-punishment values should rise with the increased damage caused by an offence. Fines exceed other punishments in efficiency as they economize resources and compensate the victim while punishing offenders. If offenders were risk neutral, society could economize on enforcement resources by reducing the probability of apprehension and increasing sanctions.

Becker and Stigler (1974) examine how to improve law enforcement in a context where enforcers (e.g., bureaucrats), imperfectly monitored by the government, can be bribed by outlaws. Their fundamental answer is "to raise the salaries of enforcers above what they could get elsewhere, by an amount that is inversely related to the probability of detection, and directly related to the size of bribes and other benefits from malfeasance." In Becker and Stigler's model, a representative enforcer receives, per period of time, a salary from the government and bribes from the private sector as long as he is not caught for which there is a constant probability each period. If the enforcer is caught, he is immediately fired and receives thereafter a salary that he could obtain in other occupations. The authors ask what is the minimum salary necessary to discourage enforcers from taking bribes. They find the minimum salary to be equal to that which he can earn elsewhere plus a surplus measuring the present value of the "temptation of malfeasance" in each period. Therefore, even with low probability of detection, wrongdoing can be eliminated with an appropriate premium. Additionally, to avoid lifetime payments to enforcers exceeding their opportunity salary, the authors propose an alternative pay structure based on an "entrance fee" equal to the temptation of malfeasance. In this scheme, the enforcer receives the remuneration that he can get elsewhere plus the interest of the entrance fee and the reimbursed entrance fee at retirement. Then he has a vested interest in foregoing bribes which would



contrarily result in the forfeiting of the entrance fee if fired. Finally, the authors briefly discuss an alternative method of improving the quality of enforcement: paying private, rather than public, enforcers on a piece-rate or on a bounty basis. They argue that in some cases these schemes can unleash powerful competitive forces that are welfare improving to society.

Rose-Ackerman (1975) considers the relationship between market structure and corruption in the government contracting process. She examines to what extent alternative contracting procedures and market structures reduce the criminal incentive as well as to what degree alternative sanctions deter corruption. In her model, the government instructs, in either a precise or vague manner, an official (bureaucrat) to buy a product (differentiated or not) sold by the private sector either by many sellers or by a monopolist. It is assumed that corruption arises as sellers attempt to bribe officials acting on behalf of the government in order to win the contract for their price-quality offer. A principal policy implication of this model is that it is optimal for the government to purchase goods also sold on the private market in order to reduce the incentive for bribery. When goods must be ordered especially for government use, the government should give as precisely as possible purchasing instructions to officials thus reducing the cost of effective surveillance and increasing the probability of detecting bribery.

Alam (1990) revisits the conclusions reached by some authors (e.g., Leff (1964)) that bribery creates auction-like conditions through the bidding by private agents for favors from bureaucrats (such as the granting of licenses and permits, for example) and, hence, improves the allocative efficiency of bureaucratic decisions. Alam claims that the assumption of auction-like conditions does not hold, mainly because officials attempt to reduce the risk of detection by refraining from diverting too many resources into illicit channels and by restricting information about access to their bribe allocation of resources. In order to increase bribe revenue, officials alter government regulations which may result in reducing the supply of controlled resources (including the officials' time), introducing new uncertainties into the supply of these resources and stretching (through adulteration) the existing supply of resources. Alam concludes that these alterations may impose long-term costs on society that are likely to outweigh any allocative gains.

Lui (1985) studies bribery in the context of a queuing model. He examines whether the queue's server can increase bribe revenue by slowing down the service and concludes that this is, most likely, not possible. In his model, customers, each with a different value of time, are ranked by their bribe payments to the queue's server; the amounts are decided solely by the customers in a non-cooperative manner. This assumption reduces the informational requirements of previous queuing models where the server decides the bribe payments. The author shows it is unlikely the server will slow down the allocation process when bribery is allowed. He also shows that the equilibrium outcome minimizes the average value of time spent in waiting by the customers.

In Johnson's (1975) paper, the top level of government, not the bureaucrats, embraces corrupt activities by both stealing from the public budget and taking bribes from the private sector. In his model, the government faces self-imposed as well as externally-imposed constraints. The former entails the government's degree of "aversion to corruption" while the latter includes the competition for office, through democratic elections, of other political parties. The government's expected costs include avoidance costs and foregone future benefits if caught and thrown out of office, while the expected benefits comprise illegal appropriation of a fraction of public funds and, through bribery, private output. Johnson concludes that corruption activity on the part of the government inflicts a net welfare loss to society. The deadweight loss results from the lower social productivity of some of the resources diverted into political activity as compared with their social productivity in their best alternatives. The most important welfare loss arises from an "excessive" resource flow into political activity and from other misallocations of corruption revenue (i.e., consumption or investment in low productive activities).

Shleifer and Vishny's (1993) model of corruption focuses on the relationship between the government (principal) and the bureaucrat (agent). In their model, the bureaucrat takes bribes from private individuals demanding government produced goods. Taking this relationship as given, the authors examine (a) what explains the level of corruption and (b) the costs of corruption.

Explaining the level of corruption involves the degree of competition among bureaucrats and consumers. Their model assumes the private sector needs various complementary government goods as inputs (i.e., licenses, permits, etc.) provided through various agencies (bureaucrats). With multiple government goods, the market structure, in the provision of these goods, sheds light on explaining the level of corruption. Shleifer and Vishny analyze three cases of market structure, (i) the different bureaucratic agencies, each supplying only one of the complementary government goods, colluding in one monopoly, (ii) the agencies, each supplying only one of the goods, acting independently as monopolists, and (iii) the agencies, each supplying more than one good, competing in the provision of the goods. The authors conclude that the third case (competition) yields the lowest level of bribes, the second (independent monopolists) the highest, and the first (collusion) in between. The total bribe revenue collection, however, is the highest in the first case where the agencies collude, precisely to maximize the total value of bribes.

Our paper contributes to the above literature by examining the economic effects of corruption in a dynamic setting. To our knowledge, ours is the first dynamic model of corruption. Interestingly, our model's conclusions for the optimal probability-punishment values are similar to those arrived at by Becker (1968) in a static setting (namely, that punishment values should rise with increased damage caused by an offense and that fines are preferred to other types of punishments).

Our analysis is motivated by the same questions posed by Schleifer and Vishny(1993), namely, what explains the level of corruption and the cost of corruption. On the latter question, our model finds the economic costs of corruption to be higher in developing countries than in developed countries. The former question is addressed within a political economy setting which provides a rationale for why in democratic countries, in which the breadth of a government's political support base is important, a certain amount of corruption may remain in equilibrium.

Finally, the model can address in a dynamic setting the role of self-imposed (e.g. degree of 'aversion to corruption') and externally-imposed constraints (electoral considerations) on the level of corruption, studied by Johnson(1975) in a static framework. The model addresses the role of self-imposed constraints through changes in the government's preferences studied in the political-economy extension of Section V. The role of externally-imposed constraints, on the other hand, can be addressed through modifications in the economically-feasible utility frontier also studied in Section V.

## II. The Model

Ours is an infinite horizon continuous time model of a competitive economy with capital accumulation in which corruption emerges endogenously. Agents can be of four types: firms, government, bureaucrats (consumers/investors/bribe-taking agents), and non-bureaucrats (consumers/investors). The sum of the mass of bureaucrats and non-bureaucrats is normalized to one for every time period. In particular,  $\mu_B(t)$  denotes the mass of bureaucrats at time  $t$  while the mass of non-bureaucrats is given by  $\mu_N(t) = 1 - \mu_B(t)$ . For simplicity, we let the size of the state  $\mu_B(t)$  be constant for all  $t$ . Finally, there exists one government player who is infinitely-lived.

Bureaucrats and non-bureaucrats own a homogeneous physical asset. The (representative) bureaucrat owns  $K^B(t)$  units of capital at time  $t$  while the non-bureaucrat owns  $K^N(t)$ . The difference between the bureaucrat and the non-bureaucrat is that the bureaucrat is employed by the government in the production of a public good. Moreover, at each period, the bureaucrat can choose to appropriate a share  $b(t)$  of the interest income earned by the non-bureaucrat,  $b(t) i(t) K^N(t)$ .  $b(t)$  is a continuous function of time.

Period  $t$  production of the homogeneous good is given by a neoclassical, strictly monotone, strictly concave, constant returns to scale production function  $f$ .  $f$  is defined over the ratio of current stock of capital to total labor effort  $L$ . Since the aim of our analysis is to show the link between corruption and capital accumulation (and not the link to consumption-leisure margins), agents are assumed to inelastically supply one unit

of labor each period. 1/ We also assume, for simplicity of the analysis (as we do not address optimal taxation questions), that all wage income is lump-sum taxed by the government. Thus, period  $t$  output--given by  $F$ --(and output per capita--given by  $f$ ) is (omitting the period  $t$  arguments),

$$f[\mu_N K^N + \mu_B K^B] \\ \equiv \frac{1}{L} F[\mu_N \bar{L} K^N + \mu_B \bar{L} K^B, \bar{L}] = F[\mu_N K^N + \mu_B K^B, 1]$$

The production sector is competitive. Therefore, the period  $t$  interest rate  $i(t) = f'[K(t)]$ , in equilibrium, where  $K(t) \equiv \mu_N K^N(t) + \mu_B K^B(t)$ .  $K(t)$  corresponds to the period  $t$  average per capita stock of capital available for production.

We now formulate the constrained optimization problems facing the non-bureaucrats, the bureaucrats and the government, respectively. In what follows, bureaucrats and non-bureaucrats share the same utility function,  $U$ , which displays standard monotonicity, concavity and Inada conditions.

#### 1. The non-bureaucrat's problem

Given a profile of bribe actions and interest rates  $\{b(t), i(t)\}_{t=0}^{\infty}$ , together with an initial stock of capital  $K^N(0) = K_0^N > 0$ , the non-bureaucrat's problem is to choose a path of consumption amounts  $\{C^N(t)\}_{t=0}^{\infty}$  so as to maximize the following discounted integral sum of utilities (discounted at the rate  $\rho_N > 0$ ):

$$\int_0^{\infty} e^{-\rho_N t} U[C^N(t)] dt$$

subject to

$$\dot{K}^N(t) = K^N(t) i(t) (1 - b(t)) - C^N(t) \quad (1)$$

$$C^N(t) \geq 0$$

$$\lim_{t \rightarrow \infty} e^{-\rho_N t} U'[C^N(t)] K^N(t) = 0$$

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1/ A standard formalization of this is to endow each agent with one unit of labor each period. As the per-period utility function is defined only over consumption amounts (and not leisure) each agent works one unit each period.

where  $C^N(t) \geq 0$  for all  $t$  from  $K_0^N > 0$  and the Inada conditions on  $U$ . The Euler equation defining the non-bureaucrat's optimal consumption plan is given by

$$-\frac{U''[C^N(t)]}{U'[C^N(t)]} \dot{C}^N(t) = i(t)(1-b(t)) - \rho_N \quad (2)$$

Equation (2) is easy to interpret. Consider for example the case of constant relative risk aversion preferences. In that case, for zero bribe shares, equation (2) reduces to the standard case in which the consumption rate of growth over time is proportional to the difference between the consumption rate of interest and the rate of discount. Whenever the equilibrium bribe share is positive, equation (2) states that the optimal consumption plan entails lower growth, *ceteris paribus*. This follows from the 'tax-like' effect of bribe activity on consumption and capital accumulation.

## 2. The bureaucrat's problem

It is assumed that bureaucrats who take bribes are caught with some probability. In particular, the probability of a bureaucrat not being caught as of time  $t$  is denoted by  $1-G(t)$ .  $g(t)$  is the density of  $G(t)$ .

Once a bureaucrat is caught, he is forced to pay a penalty  $\theta(b(t))$  and thus consumes out of his interest income that period plus the bribe proceeds that period net of the penalty  $1/\theta(b(t))$ . Moreover, he is forced to relinquish all his capital stock  $K^B(t)$  to an externally administered fund that earns an exogenously given interest rate  $i^*$  thereafter and which, for simplicity, is assumed constant over time.

The bureaucrat seeks to maximize his expected discounted integral sum of utilities of consumption, given in expression (3) below. Expression (3) can be interpreted as follows. If the bureaucrat is not caught as of time  $t$  (which occurs with probability  $1-G(t)$ ), then utility from consumption  $U[C^B(t)]$  is collected; if he is caught at time  $t$  (which occurs with probability density  $g(t)$ ) then he pays a penalty  $\theta(b(t))$ , and thus must consume out of his current period interest income and bribe proceeds net of the penalty.

Formally, given an initial stock of capital  $K^B(0) = K_0^B > 0$  and sequences

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1/ For simplicity of notation we denote penalty functions, which are defined over bribe proceeds at the time of arrest, only as a function of the bribe share.

$$\int_0^{\infty} e^{-\rho_B t} \{ (1-G(t)) U[C^B(t)] + g(t) \{ U[i(t) K^B(t) + \frac{b(t) \mu_N i(t) K^N(t)}{\mu_B} - \theta(b(t))] + W[K^B(t)] \} \} dt \quad (3)$$

of interest rates, stocks of capital of the non-bureaucrats and government penalty functions  $\{i(t), K^N(t), \theta(b(t))\}_{t=0}^{\infty}$ , the bureaucrat chooses sequences of consumption and bribe shares  $\{C^B(t), b(t)\}_{t=0}^{\infty}$  so as to maximize the discounted integral sum of expected utilities given in expression (3) (discounted at the rate  $\rho_B > 0$ ) subject to:

$$\dot{K}^B(t) = i(t) K^B(t) + \frac{b(t) \mu_N i(t) K^N(t)}{\mu_B} - C^B(t) \quad (4)$$

$$C^B(t) \geq 0, \quad 1 \geq b(t) \geq 0$$

$$g(t) = \tilde{h}(b(t)) [1-G(t)] \quad (5)$$

where  $W[K^B(t)]$  is the solution to the following standard utility maximization problem faced by the bureaucrat once caught given that upon detection he is forced to transfer all capital  $K^B(t)$  to an externally administered fund that earns a (constant) interest rate  $i^*$  thereafter:

$$\int_t^{\infty} e^{-\rho_B(s-t)} U[C^B(s)] ds$$

subject to:

$$\dot{K}^B(s) = i^* K^B(s) - C^B(s)$$

$C^B(s) > 0$  for all  $s$  from  $K^B(t) = K_t^B > 0$  and the Inada conditions on  $U$ , (5) defines the hazard rate of arrest  $\tilde{h}(b(t))$ , which represents the conditional density of arrest for a bureaucrat. In what follows, we assume a constant

hazard rate  $\tilde{h}(b(t)) = \tilde{h}$  for all  $t$ , for simplicity. <sup>1/</sup>

It can be shown that the bureaucrat's consumption evolves according to

$$\dot{C}^B(t) = - \frac{\tilde{h}}{U''[C^B(t)]} \{ -U'[C^B(t)] + W'[K^B(t)] + U'[i(t)K^B(t)] + \frac{b(t)\mu_N i(t)K^N(t)}{\mu_B} - \theta(b(t)) \} [ \frac{\mu_B \theta'(b(t))}{\mu_N K^N(t)} (1 - \frac{\rho_B}{i(t)}) + \rho_B ] \quad (6)$$

Equation (6) illustrates the dynamics of the bureaucrat's optimal consumption plan. In particular, (6) is composed of three terms; the first is negative while the other two are positive. The first term is negative reflecting that over time the cumulative probability of arrest increases and thus it is optimal to consume more earlier on (this should be thought of as the intertemporal effect of bribe activity on bureaucratic consumption); the two other terms are positive reflecting the impact effect of bribe activity on consumption (this should be thought of as the static effect of bribe activity on bureaucratic consumption).

### 3. The government's problem

The model's formulation of the government's behavior is consistent with a wide variety of objective functions (including utilitarian, Pigovian and Rawlsian welfare functions). Specifically, as will be shown in Sections IV and V, the government affects the equilibrium evolution of the economy's capital stock and public good spending through the choice of penalty functions on corruption activity. Equilibrium is solved for a given government penalty function; thus, the paper does not take a position on the government's objective (welfare) function. This is left to the reader's choice.

The government does the following:

--employs bureaucratic labor in the production of the public good. The production function for the public good is assumed to be linear (constant returns);

--chooses a penalty function that maps caught bureaucrats' bribe proceeds into penalties paid to the government; for economy of notation, we denote penalty functions, which are defined over bribe shares times non-bureaucrat's interest income (which make bureaucrats'

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<sup>1/</sup> See Leung(1991) for a model of optimal punishments that also utilizes a hazard rate of arrest formulation.

total bribe proceeds the relevant variable over which to impose penalties), by  $\theta(b(t))$ . Moreover, the choice of penalty function is made once over the government's infinite horizon problem;

--taxes wage income in each period. Since this paper is not concerned with labor supply considerations of corruption activities, the government is assumed to impose a lump-sum tax on all wage income from bureaucrats and non-bureaucrats alike; 1/

--fills bureaucratic positions left vacant by arrested bureaucrats with newly born individuals (where the birth rate is assumed, for simplicity and clarity of exposition, to coincide with the probability of arrest so as to preserve  $\mu_B$  constant over time. Moreover, the government transfers to every successor of an arrested bureaucrat an amount equal to the capital stock the arrested bureaucrat would have had had he not been caught -this assumption is made for simplicity so as to preserve the representative bureaucratic agent construct; otherwise, we would have a countable infinite number of agents). At  $t$  the latter mentioned transfers amount to  $\mu_B \bar{L} h [K^B(t) + \dot{K}^B(t)]$ , where  $h$  corresponds to the fraction of total bureaucrats arrested at  $t$  as implied by the hazard rate of arrest  $\bar{h}$ .

Finally, public good spending  $Q(t)$  (which enters into bureaucrats' and non-bureaucrats' utility functions in a separable manner) results from the above mentioned government actions. The above imply the government's budget constraint at  $t$  is given by

$$\mu_B \bar{L} h [K^B(t) + \dot{K}^B(t)] + Q(t) = \mu_B \bar{L} h \theta(b(t)) + \bar{L}(1-\alpha)K^\alpha(t)$$

where  $f[K] = K^\alpha$  so that the second term in the right-hand side of the above expression denotes the income accruing to labor.

### III. Equilibrium Analysis

The dynamic general equilibrium of this economy evolves according to the following conditions where, for tractability, we choose a constant elasticity of substitution utility function specification and quadratic penalty rules. Specifically, we let

$$U[C] = \frac{C^{1-\sigma}}{1-\sigma} \quad 0 < \sigma < 1$$

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1/ Removing the possibility of lump-sum taxation would further strengthen the efficiency costs of corruption in the model.



so that  $U'[C] = C^{-\sigma}$  and  $U''[C] = -\sigma C^{-\sigma-1}$ , and  $\theta(b(t)) = \frac{\theta}{2} b^2(t) \frac{\mu_N i(t) K^N(t)}{\mu_B}$ ,

in symmetric equilibrium, where  $\theta > 0$ .

### 1. Market clearing

At each period, the sum total of consumption of non-bureaucrats, not-caught bureaucrats, caught bureaucrats plus investment by the non-bureaucrats and the not-caught bureaucrats plus government transfers plus public good spending by the government must exhaust total production. Formally,

$$\begin{aligned} & \mu_N C^N(t) + \mu_N K^N(t) + \mu_B h C^B(t) |_{caught} \\ & + \mu_B (1-h) C^B(t) |_{not-caught} + \mu_B K^B(t) + \tilde{Q}(t) + \mu_B h K^B(t) = K^\alpha(t) \end{aligned} \quad (7)$$

where

$$\tilde{Q}(t) = \frac{Q(t)}{L}$$

### 2. Non-bureaucrats' maximizing behavior

In equilibrium, non-bureaucrats maximize their utility. Optimal consumption behavior by non-bureaucrats is given by their Euler equation (2). Moreover, non-bureaucrats must obey their flow budget constraints (1).

### 3. Bureaucrats' maximizing behavior

The evolution of bureaucrats' consumption and bribe shares over time are given by (8) and (11) below, where (9) and (10) denote the bureaucrat's flow budget constraint at  $t$ , when caught and not-caught, respectively.

$$\begin{aligned} C^B(t) |_{not-caught} &= \frac{-\tilde{h}}{U''[C^B(t) |_{not-caught}]} \{-U'[C^B(t) |_{not-caught}] \\ & + W'[K^B(t)] + U'[C^B(t) |_{caught}] \left[ \frac{\mu_B}{\mu_N K^N(t)} \theta'(b(t)) \left(1 - \frac{\rho_B}{i(t)}\right) + \rho_B \right]\} \end{aligned} \quad (8)$$

where

$$C^B(t)|_{caught} = i(t)K^B(t) + \frac{b(t)\mu_N i(t)K^N(t)}{\mu_B} - \theta(b(t)) \quad (9)$$

$$C^B(t)|_{not-caught} = i(t)K^B(t) + \frac{b(t)\mu_N i(t)K^N(t)}{\mu_B} - K^B(t) \quad (10)$$

Equation (11) is derived from the bureaucrats' optimal choice of bribe share at  $t$ .

$$\begin{aligned} & g(t)U' [C^B(t)|_{caught}] \left[ \frac{\mu_N i(t) K^N(t)}{\mu_B} - \theta'(b(t)) \right] \\ & = - \frac{\mu_N i(t) K^N(t)}{\mu_B} (1-G(t)) U' [C^B(t)|_{not-caught}] \end{aligned} \quad (11)$$

#### 4. Production equilibrium

Competitive production equilibrium implies the consumption rate of interest equals the marginal product of capital, namely,

$$i(t) = \alpha K^{\alpha-1}(t) \quad (12)$$

Finally, the government's flow budget constraint holds by Walras' Law (given (1), (7), (9) and (10)).

Thus, we have eight equations ((1), (2) and (7)-(12)) in 8 unknowns:  $i(t)$ ,  $Q(t)$ ,  $C^B(t)|_{caught}$ ,  $C^B(t)|_{not-caught}$ ,  $K^B(t)$ ,  $K^N(t)$ ,  $b(t)$  and  $C^N(t)$ .

#### IV. Determination of Stationary Equilibrium

Substituting for the interest rate expression (12), we can restate the equilibrium system in the steady state as a function of seven variables denoted by subscripts  $ss$  for steady state values.

Computation of stationary equilibrium yields the following proposition.

Proposition: In stationary equilibrium, the bribe share is decreasing at an increasing rate with respect to increases in the penalty parameter, and the average per capita stock of capital available for production is increasing in the penalty parameter. Formally, in stationary equilibrium:

--The bribe share,  $b_{ss}$ , is given by

$$b_{ss} = -\frac{1}{2} \left\{ \frac{\rho_N}{\bar{h} + \rho_B} - 1 + \sqrt{\left( \frac{\rho_N}{\bar{h} + \rho_B} - 1 \right)^2 - \frac{4\rho_N}{\theta}} \right\} \quad (13)$$

Moreover,  $\partial b_{ss}/\partial \theta < 0$  and  $\partial^2 b_{ss}/\partial \theta^2 > 0$ ;

--The average per capita stock of capital available for production  $K_{ss}$  is

$$K_{ss} = \left( \frac{\rho_N}{\alpha} \right)^{\frac{1}{\alpha-1}} \left\{ 1 + \frac{1}{2} \left[ \frac{\rho_N}{\bar{h} + \rho_B} - 1 + \sqrt{\left( \frac{\rho_N}{\bar{h} + \rho_B} - 1 \right)^2 - \frac{4\rho_N}{\theta}} \right] \right\}^{\frac{1}{1-\alpha}} \quad (14)$$

Moreover,  $K_{ss}$  is increasing in the penalty share  $\theta$ ;

--Bureaucratic sector capital  $K_{ss}^B$  is

$$K_{ss}^B = \frac{K_{ss}}{\mu_N \Delta + \mu_B} \quad (15)$$

where  $\Delta \equiv K^N/K^B$  denotes the ratio of capital held by non-bureaucrats and bureaucrats which, in equilibrium, is given by

$$\Delta = \frac{\Phi \alpha K_{ss}^{\alpha-1}}{\frac{\mu_N b_{ss}}{\mu_B} \left\{ \frac{\theta b_{ss}}{2} - \Phi \alpha K_{ss}^{\alpha-1} \right\}}$$

where

$$\Phi \equiv 1 - \left[ \frac{\bar{h} (\theta b_{ss} - \alpha K_{ss}^{\alpha-1})}{\alpha K_{ss}^{\alpha-1}} \right]^{\frac{1}{\sigma}}$$

and where  $b_{ss}$  and  $K_{ss}$  are as given in (13) and (14), respectively;

--Non-bureaucratic sector capital  $K_{ss}^N$  is

$$K_{ss}^N = \frac{1}{\mu_N} \{ K_{ss} - \mu_B K_{ss}^B \} \quad (16)$$

where  $K_{ss}$  and  $K_{ss}^B$  are as given in (14) and (15), respectively.

Finally,  $\bar{Q}_{ss}$  is determined from the market-clearing condition.

## V. Equilibrium Implications

This section discusses the implications of the model on welfare, efficiency and the choice of anti-corruption policies from a politico-economic perspective. The politico-economic section provides a rationale for why one would not observe the elimination of corruption activity altogether even when it is feasible to do so. The model also yields implications for the effect of anti-corruption government policies on capital accumulation according to the economy's level of development and the effects of corruption on welfare.

In assessing the implications for policy, the model developed above was modified to include public good consumption in the (representative bureaucrat and non-bureaucrat) agent's preferences. In particular, we posit a preference specification that is Cobb-Douglas with respect to the constant relative risk aversion (CRRA) transformation of the private consumption good (with exponent  $\gamma$ ) and on the public good (with exponent  $1-\gamma$ ). In what follows it is useful to remember the interpretation of  $\gamma$  and  $1-\gamma$  as the consumption expenditure shares of the market and public goods, respectively:

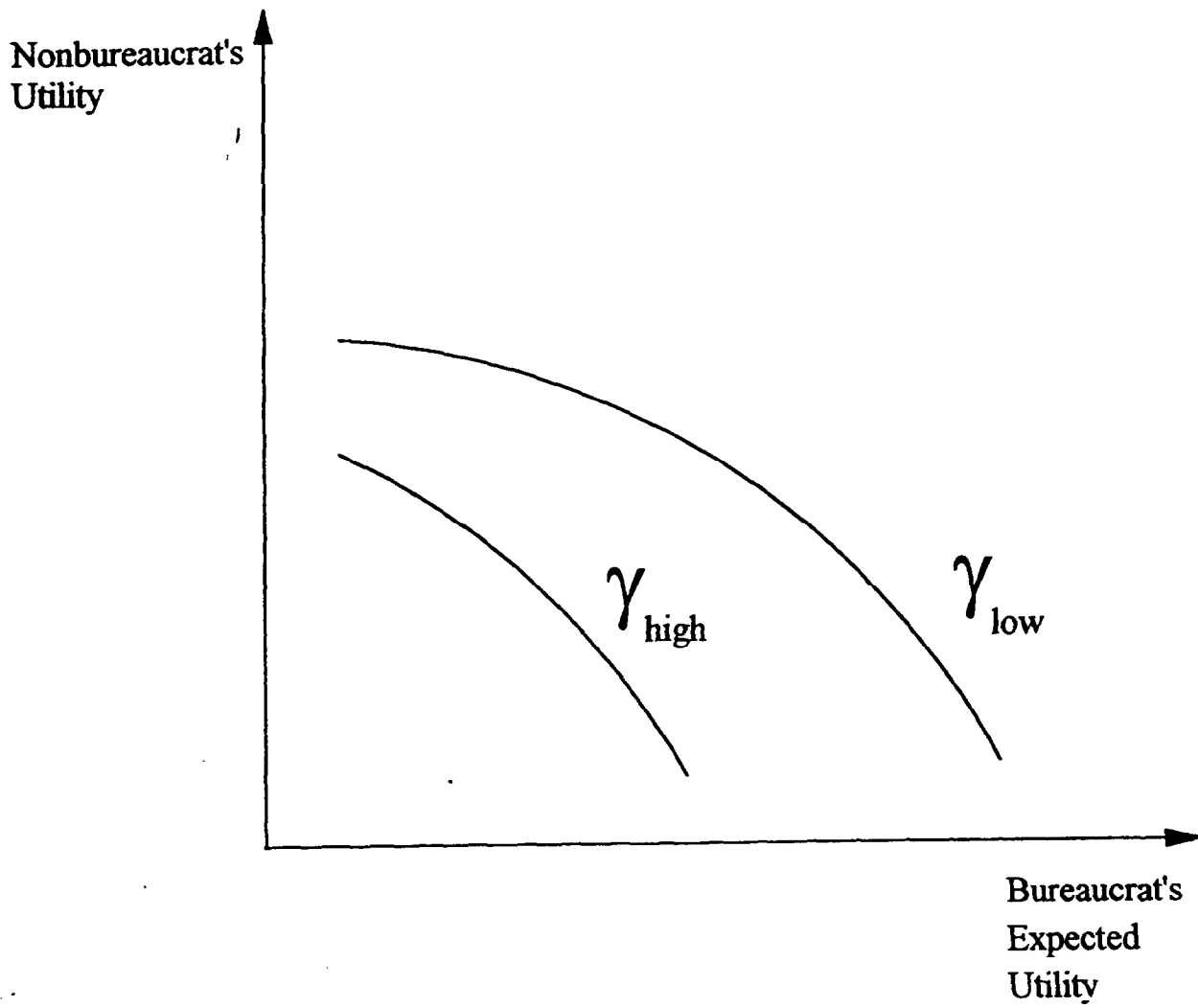
$$\left(\frac{C^{1-\sigma}}{1-\sigma}\right)^{\gamma} Q^{1-\gamma}, \quad 0 < \gamma < 1$$

### 1. Welfare

Figure 1 depicts the role of the market sector on the expected utility frontier depicting the stationary expected utilities of bureaucrats and non-bureaucrats.

From the Cobb-Douglas specification on preferences, the  $\gamma$  parameter denotes the expenditure share on market goods. This parameter can be associated with the degree of development of an economy, namely, the lower the parameter the higher the degree of development. For example, the expenditure share of industrial countries on public goods such as defense,

Figure 1  
The Expected Utility Frontier under Corruption:  
The Role of the Market Sector



education, health and infrastructure is generally higher than for developing countries. <sup>1/</sup>

Figure 1 assigns the degree of development interpretation to the  $\gamma$  parameter, as discussed above, to assess the effects of anti-corruption penalties on welfare. For example, from Figure 2 it is clear that the expected utility of bureaucrats increases as the penalty parameter decreases. Figure 1 shows that the relative utility of nonbureaucrats in developing countries ( $\gamma$  high) to those in developed countries ( $\gamma$  high) is highest for high levels of anti-corruption penalties.

## 2. Political economy of anti-corruption government policies

The model developed above can accommodate political-economy considerations. This is succinctly captured in Figure 2 where the northern quadrant in the right-hand panel depicts both the economically feasible utility frontier which is concave and a government's political support indifference curve which is convex. <sup>2/</sup> The utilities of non-bureaucrats and bureaucrats and the penalty level marked by the dotted line are stationary politico-economic equilibrium levels.

The economically feasible utility frontier is derived from the left-hand panel which depicts the relationship between anti-corruption penalties and stationary utility for non-bureaucrats (concave and increasing relationship) and bureaucrats (convex and decreasing relationship). The left-hand panel is connected to the northern quadrant in the right-hand panel via the southern quadrant in the right-hand panel which depicts a 45 degree line.

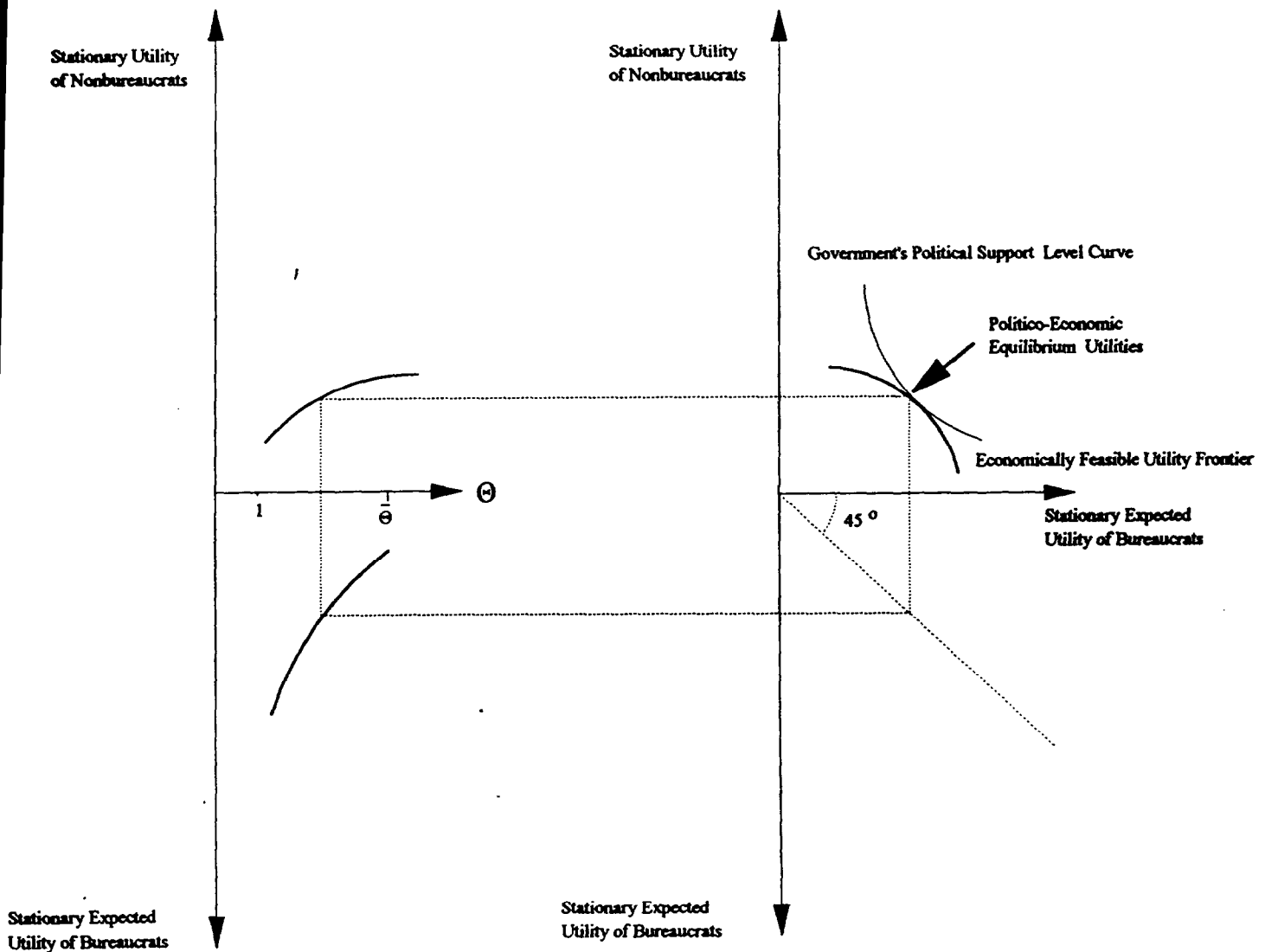
A government's choice of the penalty parameter  $\theta$  determines the stationary utility of non-bureaucrats as well as the stationary expected utility of bureaucrats in the left-hand panel. The latter is mapped onto the northern quadrant of the right-hand panel in Figure 2 through the identity map appearing in the southern quadrant of the right-hand panel. In such a way, one can derive the 'economically feasible utility frontier' of this economy. A choice of penalty parameter  $\theta$  is consistent with a politico-economic equilibrium only if the government's political support

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<sup>1/</sup> In 1990, for example, total expenditure on defense, social security, education, health, and housing and economic affairs, as a percentage of GDP, for the United States and Germany were 18.1 and 24.9. For developing countries in general, this figure was about half of that for industrial countries, for example, Argentina 7.4, Bolivia 10.3, Chile 17.4, Dominican Republic 10.0, El Salvador 6.8, Ecuador 8.2, Mexico 7.7, Paraguay 5.3, Philippines 11.4, Sierra Leone 6.4, Uruguay 20.7 (IMF, Government Finance Statistics, Yearbook, 1993).

<sup>2/</sup> Political support functions make explicit that governments operate with the influence or the support of interest groups such as taxpayers, subsidy recipients and bureaucrats. Bently (1908) and Becker (1983) pioneer the use of political support functions in analyzing actual government behavior.

Figure 2  
Political Economy of Anti-Corruption  
Government Policies



level (indifference) curve is tangent to the economically feasible utility frontier.

Such politico-economic analysis suggests that a certain amount of corruption may remain in equilibrium ensuing from the role of bureaucrats in the government's political support base. Moreover, the model could be extended to explicitly account for the costs of eliminating corruption, which would provide an additional reason why a certain amount of corruption may remain in equilibrium. This is because of the social opportunity cost associated with a large enough penalty needed to eliminate corruption altogether could become prohibitive in the sense of substantially crowding out public good output.

### 3. Efficiency

In stationary equilibrium, the effect of anti-corruption penalties on the economy's capital stock can be greater in developing countries. In particular, the elasticity of the steady state average per capita stock of capital with respect to increases in anti-corruption penalties,  $\eta$ , is increasing in the income share accruing to capital. It can be shown that  $\eta$  corresponds to:

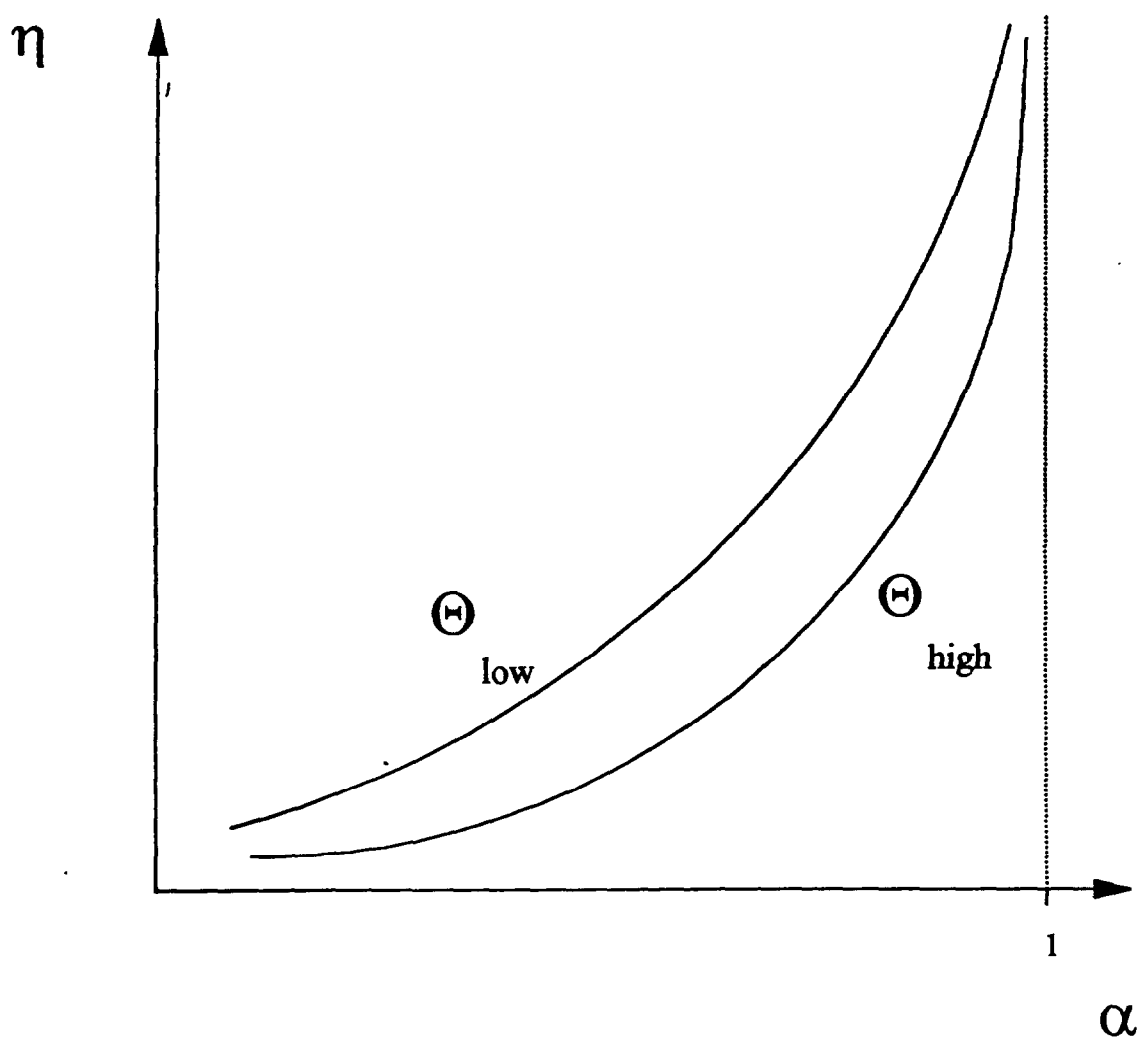
$$\eta = \frac{\partial K}{\partial \theta} \frac{\theta}{K} = \frac{\rho N}{\theta(1-\alpha)(1-b_{ss}) \sqrt{\left(\frac{\rho N}{h+\rho_B} - 1\right)^2 - 4 \frac{\rho N}{\theta}}} \quad (17)$$

The above expression shows that the elasticity of the average per capita stock of capital with respect to increases in the anti-corruption penalty parameter is higher for developing countries in which the income share accruing to capital,  $\alpha$ , is higher (see e.g. Romer (1989, p.63) for a discussion of the latter and Figure 3 for a graphic illustration of the result). The mechanism at work is the following. Increases in the penalty parameter lead to increases in penalty revenues to the government and thereby to increases in public good output since the government is able to afford higher expenditure levels of the public good. The impact is greater in developing countries because the interest rate in developing countries is higher than in developed countries. Consequently, increases in the penalty parameter lead to larger increases in government revenues in developing countries because penalty revenues are an increasing function of bribe income which in turn is increasing in non-bureaucrats' interest income.

Figure 3 also shows how the relationship between  $\eta$  and  $\alpha$  varies according to the penalty level  $\theta$ . In particular, for a fixed level of development (fixed  $\alpha$ ), the sensitivity of the average per capita stock of



Figure 3  
The Responsiveness of the Average Per Capita  
Stock of Capital to Anti-Corruption Penalties:  
The Role of Development



capital to increases in anti-corruption penalties,  $\eta$ , is higher the lower the anti-corruption penalty level  $\theta$ .

Finally, Figure 4 shows how increases in anti-corruption penalties lead to higher increases in per capita public good output in developing countries, where  $\alpha$  is high.

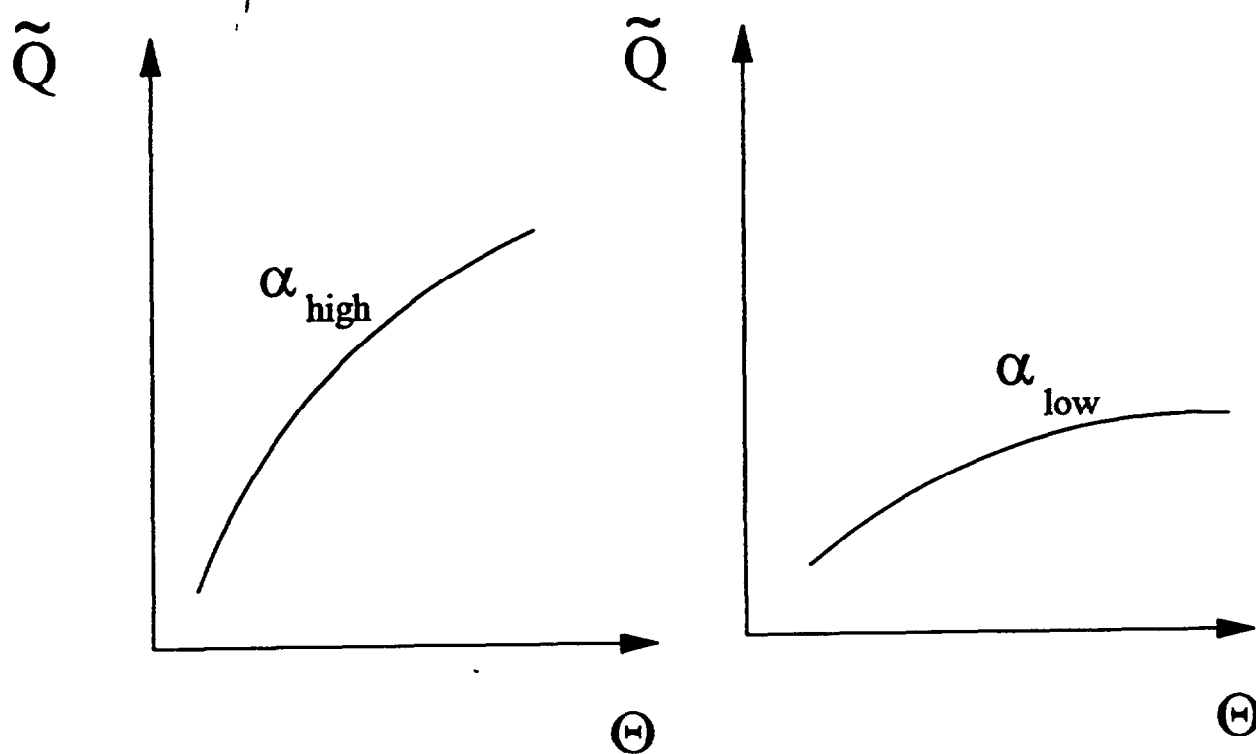
## VI. Concluding Comments

The existence of official corruption poses important policy questions for both developed and developing countries. The issue is arguably more important to currently reforming economies. Such countries have typically devoted little attention to policies affecting the penalties imposed on corruption activities, and policies designed to improve the monitoring of bureaucrat's behavior (i.e., policies leading to increases in the probability of detecting bribe activity, see e.g., Calvo and Frenkel (1991)).

This paper studies the relationship between bribes and capital accumulation through the development of a dynamic general equilibrium model of perfect competition in which bribe-taking activity by bureaucrats is endogenous. Bribery is facilitated and nurtured by an institutional informational setting in which the government can detect corruption activity only probabilistically. The paper provides a framework in which in equilibrium the government finds optimal not to eliminate corruption activity altogether. Moreover, the paper also derives results suggesting the effect of anti-corruption penalties on the capital stock is greater for developing countries. The latter result is consistent with Becker's (1968) findings, in the context of a static model, that the optimal probability-punishment values should rise with increased damage, as measured by his posited social loss function, caused by an offense; and that fines, whenever possible, are preferable to other types of punishments as they economize societal resources and compensate the victim (through greater public good output in our model) while punishing offenders.

The framework developed in this paper aims at providing a basic building block for the study of the effects of illegal activities on reform/stabilization programs. Other interesting extensions include allowing the hazard rate to depend on the bribe share and accounting for non-bureaucratic corruption activities (for example, through black markets).

Figure 4  
Per Capita Public Good Output and Anti-Corruption Penalties:  
The Role of Development



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