Power, Compensation and Corruption: Theory and Evidence*

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Abstract

Using a multi-period model of corruption in a heterogeneous society, we show that societal corruption and output crucially depend on the interplay among the productivity distribution, the societal compensation structure, and the distribution of power. The power distribution influences the curvature of the output-maximizing societal compensation structure in any period and the relation between societal corruption and inequality. Societal corruption varies in a U-shaped manner with the bias of the power distribution. Corruption attains its minimum in a society characterized by relatively higher levels of "petty" corruption compared with "high-level" corruption. Societies with differing power distributions can experience dramatically divergent evolutions of their corruption levels and output. The positive implications of our theory for the relations among corruption, compensation, power, inequality, and growth are consistent with prior empirical evidence. Our theory also leads to the testable prediction that societal corruption varies in a U-shaped manner with the *relative* level of public sector wages. We find significant support for this prediction in our empirical analysis. From a policy standpoint, our results suggest that high level corruption should be targeted by legal systems in developed economies while petty corruption is relatively more pernicious in developing economies, and that highly productive economies should have relatively powerful public sectors.

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I. Introduction

The causes and effects of corruption have been extensively investigated in prior research.[1] The effect of the remunerations of individuals on their incentives for corruption is an important theme in the literature (for example, Becker and Stigler 1974, Besley and McLaren, 1993, Mookherjee and Png, 1995). The role of differing corruption opportunities in different occupations, as well as that of the resulting distortions caused by "rent-seeking" and the misallocation of talent, are prominent strands in the literature as well (see Krueger, 1974, Bhagwati, 1982, Murphy et al, 1991, 1993, Acemoglu and Verdier, 1998). Nevertheless, the effects of the *interplay* among compensation, the distribution of power, and corruption at the *societal* level remain unclear.

In this article, we develop a unified framework to investigate the joint effects of the distributions of productivities, remuneration, and power across the heterogeneous activities in a society on societal corruption, output, and growth. We show that the distribution of power significantly influences the nature of the output-maximizing or corruption-minimizing *societal compensation structure* in any period and the relation between societal corruption and *inequality*. Societal corruption varies in a U-shaped manner with the *bias* of the power distribution. Corruption attains its minimum in a society characterized by relatively higher levels of "petty" corruption compared with "high-level" corruption. In such a society, if the proportion of agents engaged in more productive activities is above (below) a threshold then agents in less productive activities enjoy greater (less) power compared with those engaged in more productive activities.

The evolutions of societal corruption and output are also significantly affected by the distribution of power. Depending on the power distribution, the society could be characterized by endemically high corruption over time with declining output; declining corruption and rising growth rates; stable corruption with declining output; and unstable corruption and growth rates. The positive implications of our theory for the relations among remuneration, power, corruption, and growth are broadly consistent with existing evidence.[2] Our results also lead to the testable prediction that societal corruption varies in a U-shaped manner with the *relative* level of public sector wages. We find significant support for this prediction in our empirical analysis. Our findings have

[1] See Bardhan (1997), Tanzi (1998), and Aidt (2003) for surveys of this vast literature.
[2] Mauro (1995), Tanzi and Davoodi (1997), Gupta et al (1998) and Leite and Weidmann (1999) empirically examine the relation between corruption, income inequality, investment, and growth. Angeletos and Kollintzas (2000) and Ahlin (2001) theoretically analyze the relation between corruption and inequality.

the policy implications that high level corruption should be targeted by legal systems in developed economies while the mitigation of petty corruption is relatively more important in developing economies.

We develop a multi-period model of corruption in a heterogeneous society with a constant population of single-period lived agents in each period. Agents differ in their human capital endowments and are engaged in diverse productive "activities" or "occupations" that are associated with differing levels of "power" which could be abused by the agents. As we model corruption across society, we view corruption more generally as the "abuse of power for personal gain" which could take many forms such as graft, inappropriate law enforcement, misallocation of resources, or corporate expropriation, and could occur in the public or private sector. In our framework, power is associated with an activity rather than being an attribute of a particular agent, that is, an agent enjoys power only insofar as he carries out a particular activity. In particular, therefore, power is *not* a consequence of an agent's acquisition of political capital *a la* Ehrlich and Lui (1999). Agents with differing human capital are naturally associated with different activities so that "occupation choice" does not play a central role in our model. We focus on the deadweight loss in societal output resulting from the misallocation of productive human capital to the abuse of power by agents in their activities. We show that the distribution of power across activities has a major impact on corruption, inequality, and output, even abstracting from the *ex ante* distortions in occupation choice created by the *promise* of corrupt rents. Hence, our results are solely driven by the underlying "structure" of the economy :– the relationships among the productivities, remunerations, and power of various occupations.

At the beginning of each period, agents receive *honest shares* of end-of-period societal output, which are their shares of output in an honest society with no corruption. Each agent invests a proportion of his human capital in his work and the rest in corrupt endeavors. His *maximum* contribution to social output – referred to as his *productivity* for expositional convenience – is determined jointly by his human capital and an occupation-specific "technology" parameter, which is the marginal product of human capital for the occupation. His *actual* contribution to societal output, however, is lowered from its maximum level by the proportion of his human capital that he expends in corruption – his *corruption level*.

The allocation of end-of-period output across agents is affected by the distribution of power and the agents' corruption levels. Power determines an agent's expected returns from corruption. An agent's payoff depends on his corruption level as well as the corruption levels of other agents. Corruption is *risky* and an agent's relative share of societal output declines if he fails in corruption.[3] An agent chooses his corruption level to maximize his expected end-of-period payoff. The *societal corruption level* is the proportional loss in societal output from its first best level owing to corruption. Therefore, output-maximization and corruption-minimization are equivalent objectives.

The existence of Nash equilibrium in mixed strategies where agents' corruption levels are determined endogenously follows using standard arguments (Myerson, 1992). We derive the corruption levels in the unique "dominant pure strategy" Nash equilibrium of a "large" population of agents. An agent's corruption level increases with his power, but decreases with his honest share. We use these expressions to investigate the effect on societal corruption and output of the interplay among the *productivity distribution* (the distribution of agents' productivities), the *distribution of power* (the relation between power and productivity) and the *societal compensation structure* (the relation between agents' honest shares and productivities).

For given productivity and power distributions, we show that societal output is maximized in any period (societal corruption is minimized) when, *ceteris paribus*, individuals' honest shares increase with their productivities and power. The corresponding societal corruption level is the *minimum attainable* societal corruption level for *given* productivity and power distributions and is generally nonzero. The prediction that an individual's compensation (as represented by his honest share) under the corruption-minimizing compensation structure increases with his power, controlling for productivity, is consistent with empirical evidence (for example, van Rijckeghem and Weder, 2001).

The curvature of the relation between power and productivity- the *bias* of the power distribution - plays a key role in our analysis. Not surprisingly, the *skew* or *curvature* of the societal compensation structure increases with the bias of the power distribution. In other words, as the distribution of power between more and less productive activities becomes more disproportionate, the remunerations of agents in those activities also become more disproportionate. The bias of the power distribution affects the incentives for corruption of the more productive agents relative to less productive ones, that is, the relative magnitudes of "high-level" and "petty" corruption in the society. Depending on the bias of the power distribution, the tradeoff between high-

[3] Cadot (1987) and Basu et al (1992) emphasize the risk of "getting caught" in corrupt activity.

level and petty corruption is optimally balanced for a society where individuals receive either disproportionately higher or lower honest shares relative to their productivities. These results contribute to the literature pioneered by studies such as Becker and Stigler (1974), Besley and McLaren (1993), and Mookherjee and Png (1995), which examine the relation between compensation and "corruptibility" at the individual level (specifically for law enforcers). They describe how individuals across society should be compensated *relative* to their productivity and power to maximize output, and highlight the importance of the societal power distribution, in particular its bias, as a determinant of the compensation structure.

Next, we show that the distribution of power also significantly affects the relations between corruption and *inequality* in the distributions of productivities and income in any period. In a society in which power increases with productivity, societal corruption *increases* with inequality. On the other hand, if power declines with productivity, but the rate of decline is above a threshold, corruption *decreases* with inequality. Finally, for a highly "inverted" power distribution where less productive activities are associated with significantly greater power, corruption varies non-monotonically with inequality. Hence, the relation between corruption and inequality could be positive, negative, or non-monotonic depending on the distribution of power. Therefore, it is important to appropriately control for characteristics of a society's power distribution in empirical analyses of the corruption-inequality relation.

Keeping the productivity distribution and the level of power associated with the "average" activity with the per-capita productivity fixed, we demonstrate that the minimum attainable societal corruption level varies *non-monotonically* in an (approximately) U-shaped manner with the bias of the power distribution. As the bias of the power distribution increases, the society varies from one that is dominated by widespread petty corruption to one that is dominated by prohibitively high levels of corruption "at the top". Corruption attains an *interior minimum* when the relative magnitudes of high-level and petty corruption are optimally balanced. The "optimal" society is characterized by relatively greater levels of petty corruption compared with high-level corruption. If the proportion of the population engaged in more productive activities is above (below) a threshold, power decreases (increases) with productivity in such a society. The corresponding societal compensation structure is increasing and strictly *concave*, that is, more productive individuals receive greater compensation, but less than proportional to their productivities.

The distribution of power in a society is significantly influenced by the characteristics of the legal system that deters, detects, and prosecutes corruption. In this context, our results have the policy implications that the legal system should target high-level corruption in developed economies with relatively larger proportions of productive agents while petty corruption should be targeted in developing economies.

As corruption is not restricted to the public sector in our model, our analysis also highlights the effect of the interplay between public and private sector corruption on corruption in the entire society. If the public sector has lower productivity, on average, than the private sector (we find significant empirical support for this hypothesis[4]), a possible proxy for the bias of the power distribution is the *relative power* of the private sector vis-à-vis the public sector. In this context, the result that output is maximized when power declines with productivity for highly productive, developed economies implies that the public sector should be relatively more powerful than the private sector in such economies. On the other hand, in developing economies which have lower proportions of productive agents, power should increase with productivity so that the private sector should be relatively more powerful. Our analysis, therefore, sheds light on the reasons why developed economies with large proportions of productive agents like Finland and Canada have very low corruption levels *and* relatively powerful public sectors (Bardhan, 1997), while undeveloped dictatorships in Africa in which most (if not all) power is in government hands have very high corruption levels. From a normative standpoint, our results support the prevailing consensus that government power and intervention should be lowered to improve economic performance in developing economies, but also imply that private sector power should be lowered in developed economies in order to mitigate "high level" expropriation.

Our analysis also leads to a novel (to the best of our knowledge), *empirically testable* implication for the relation between societal corruption and the relative level of public sector wages. By our earlier results, as the bias of the power distribution increases, the output-maximizing compensation structure becomes increasingly skewed in favor of the agents engaged in more productive activities.[5] If the private sector is more productive on

[4] Using data from the Groningen Growth and Development Center, we find that the average per capita labor productivity in the private sector for OECD countries significantly exceeds the per capita labor productivity in public administration.
[5] We take the philosophical position that a society's power distribution, which is largely determined by its political and legal institutions, is relatively "sticky" compared with its compensation structure. In other words, the time horizon over which the wages of individuals could be altered so that they are "optimal" (output-maximizing) *given the power distribution* is much smaller than the horizon over which the power distribution itself could be altered. Hence, societies

average than the public sector, this result implies that the average level of public sector wages *relative* to the per-capita compensation in the economy *declines* with the bias of the power distribution. Our prediction that societal corruption varies in a U-shaped manner with the bias of the power distribution, therefore, implies that societies with very low *or* very high *relative* levels of public sector wages are more corrupt than those with intermediate relative levels. Controlling for several important determinants of corruption identified in previous literature (Mauro, 1995, Ades and Di Tella, 1999, Treisman, 2000), we find significant support for this implication in our empirical analysis.

Finally, we investigate the evolution of societal corruption and output over time. We adopt a perspective similar to that of *learning by doing* models (Barro and Sala-i-Martin 2004) by positing that human capital investments and production lead to external "technology" spillovers that enhance the marginal product of human capital in future periods. Human capital that is expended in corruption, however, lowers the level of spillovers so that technological progress is also lowered. Hence, corruption has short-term and long-term detrimental effects by lowering output in the current period and in future periods by hampering technological progress.

The dynamics of societal corruption and economic output are complex with the distribution of power playing a pivotal role in determining the evolution of the society. We first investigate the dynamic variation of corruption and output when the power distribution is *fixed* over time and the compensation structure in each period maximizes end-of-period output. The evolution of the society is significantly affected by the power distribution. If the power distribution is increasing and convex, the society has endemically high corruption levels. Per capita output and the growth rate steadily decline over time representing the debilitating effects of high corruption levels. If the distribution of power is increasing and concave, societal corruption and output decline gradually over time, while growth rates are negative, but stable. If the distribution of power is decreasing with the rate of decline being above a threshold, societal corruption declines rapidly over time, while per capita output and the growth rate rise significantly. Finally, for a highly inverted power distribution where power declines rapidly with productivity, corruption varies non-monotonically and eventually increases with time,

could have differing distributions of power that need not be optimal. However, *given a power distribution*, the compensation structure maximizes output.

while the growth rate is unstable. Consistent with Mauro (1995), the relation between corruption and growth is generally negative. However, the *sensitivity* of this relation crucially depends on the power distribution.

We then carry out a normative analysis (see footnote 5) by examining the evolution of the "optimal" society where the bias of the power distribution in each period is *also* chosen to maximize output. As expected, societal corruption declines and per capita output and the growth rate increase significantly over time. The society approaches a "steady state" marked by low corruption and a high, stable growth rate. More interestingly, however, inequality in the distributions of productivities and income *increases* over time so that the society approaches one where there is substantial inequality in the income of individuals.

Broadly, our study highlights the importance of the distribution of power in society in determining the relation between corruption and compensation, the variation of corruption with inequality, and the evolutions of corruption and output. Societies with comparable initial levels of corruption, but differing power distributions, can experience dramatically divergent evolutions of their corruption levels and output leading to substantial cross-sectional variation in corruption levels and economic performance. The distribution of power is likely to be largely determined by the political and legal institutions in the society. Consistent with a growing body of recent work (see the survey by Aidt, 2003), our study, therefore, suggests that the society's institutional features are key determinants of the compensation of individuals across society, the relation between corruption and inequality, and the dynamics of corruption, output, and inequality. Insofar as a society's institutions and, therefore, its power distribution, are likely to be "sticky", our results also explain the marked *persistence* of corruption and the importance of the *history* of corruption in determining current corruption levels (Bardhan, 1997). As factors such as the exposure to democracy, the legal system, and federalism are likely to significantly influence the power distribution, our theory might shed some light on how these factors affect corruption.

The plan for the paper is as follows. In **Sections II** and **III,** we develop the model. In **Section IV,** we examine the relations among societal corruption, the distribution of power, the compensation structure, and inequality in a representative period. **Section V** presents our empirical analysis. In **Section VI,** we examine the evolutions of corruption and output. **Section VII** concludes. All proofs are provided in the **Appendix**.

II. The Model

We model a society over an infinite time horizon with dates $0,1,2,....$. In each period $[t,t+1];t\in Z_+$ (alternatively referred to as the t^{th} period), the society has a population of N agents who live for a single period. We begin by focusing on a specific, *representative* time period $[t,t+1];t\in Z_+$. In Section VI, we describe the dynamics of the society. Throughout, we use superscripts denoting the time period for variables that are time-dependent and denote variables that are fixed over time without superscripts. Agents differ in their human capital endowments. There are g_i^t agents with human capital $h_i^t\in(0,\infty)$ who carry out a productive "activity" or "occupation" $i\in\{1,...,n\}$. Hence, we have $\sum_{i=1}^{n} g_i^t = N$.

The agents in the society during the t^{th} period make decisions at the beginning of the period, and their payoffs occur at the end of the period. The *maximum possible* output generated by *each* agent involved with activity $i\in\{1,...,n\}$ in period t is

(2.1) $$v_i^t = T_i^t h_i^t$$

In (2.1), $T_i^t\in(0,\infty)$ is a "technology parameter" representing the marginal product of human capital associated with activity i in period t. For now, this is merely a parameter that affects the output generated in period t by agents carrying out activity i. In Section VI, we model the evolution of the technology parameters. For expositional convenience, and to clearly distinguish them from the human capital endowments $\{h_i^t\}$, we refer to the variables $\{v_i^t\}$ in (2.1) as the *productivities* of the activities $i\in\{1,...,n\}$. Since the agents carrying out a particular activity are identical, we also alternately refer to the variable v_i^t as the productivity of the agents carrying out activity $i\in\{1,...,n\}$.

Note: If productivity is defined as an agent's *actual* contribution to societal output, then v_i^t is strictly the *maximum productivity* of an agent carrying out activity i because an agent's actual contribution to societal output is lower than its maximum level due to corruption. We refer to the variables $\{v_i^t\}$ simply as "productivities" for expositional convenience.

Each of the g_i^t agents in activity i receives an "honest share" $w_i^t \in [0,\infty)$, which determines his share of societal output in an honest society with no corruption. Hence, we have $\sum_{i=1}^{n} g_i^t w_i^t = 1$ by definition. Each activity i is also associated with a level of "power" $p_i^t \in (0,\infty)$ that an agent carrying out the activity could misuse for personal gain. For example, the activities of a firm CEO, a senator, an engineer, and a government servant could be associated with different levels of power that the individuals carrying out these activities could abuse. The variables $\{g_i^t, h_i^t, v_i^t, w_i^t, p_i^t; i=1,...,n\}$ are publicly observable.

As we model corruption across society, we view corruption more generally as the "abuse of power by agents for personal gain" that could take many forms such as graft, inappropriate law enforcement, misallocation of resources, or corporate expropriation.[6] In particular, the abuse of power could occur in the public or private sector. Corruption and its detrimental effects on society arise from agents misallocating their human capital to the abuse of power rather than in beneficial production. Note that, in our framework, power is associated with an activity rather than being vested with an individual. An agent enjoys power only insofar as he is associated with a particular activity. For example, a CEO could misuse his position to invest the firm's capital in inefficient projects in exchange for side payments. A lawyer could misuse his position to fabricate evidence to get a guilty client exonerated. In either case, the individuals abuse power that is associated with the activity that they perform. In particular, power is *not* the result of the acquisition of "political capital" by agents as in Ehrlich and Lui (1999).

If all individuals carry out their activities honestly, societal output $\bar{Y}^t$, which occurs at the end of the period is (recall that g_i^t individuals carry out activity i)

(2.2) $$\bar{Y}^t = (\sum_{i=1}^{n} g_i^t v_i^t)$$

The end-of-period payoff of an agent carrying out activity i in an honest society is

(2.3) $$x_i^t = w_i^t \bar{Y}^t$$

[6] Carillo (2000) studies the effect of graft and bribes on the practice of corruption. Shi and Temzelides (2004) analyze bureaucratic corruption in a market with decentralized exchange and "lemons".

The power p_i^t associated with activity i determines the returns from the abuse of power by an agent carrying out the activity. The *distribution of power* $\{p_i^t\}$ depends, in particular, on the political and legal institutions that determine the power associated with the various activities in the society. For example, in a government-controlled economy, activities in public administration are likely to be associated with relatively greater power than in a market economy with low levels of government intervention. The impact of the distribution of power $\{p_i^t\}$ on corruption is a key focus of this study.

At time t, each individual invests a portion of his human capital in production and expends the remainder in abusing the power that he enjoys as a result of the activity he performs. The *corruption level* $a_{i,j}^t \in [0,1]; i \in \{1,...,n\}; j \in \{1,..., g_i^t\}$ of an agent j carrying out activity i is the proportion of his human capital that he expends in corruption. The corruption choices of agents are *unobservable*. Economic output at the end of the period is determined by the total amounts of human capital that are spent productively and expended in corruption and is given by

$$Y_{\{a_{i,j}\}}^t = \sum_{i=1}^{n} T_i^t \sum_{j=1}^{g_i} [(1-a_{i,j}^t)h_i^t] = \sum_{i=1}^{n} \sum_{j=1}^{g_i} [(1-a_{i,j}^t)v_i^t] \tag{2.4}$$

The second equality above follows from the relation (2.1) between human capital endowments and productivities. The subscript on the end-of-period societal output $Y_{\{a_{i,j}\}}^t$ explicitly indicates its dependence on the corruption choices of individuals. Henceforth, to simplify the notation, we drop this subscript.[7] From (2.1) and (2.4), the proportion of human capital that is expended in corruption does not contribute to societal output.[8] From (2.2) and (2.4), we note that societal output is lowered below its "first best" level $\sum_{i=1}^{n} g_i^t v_i^t$ due to individuals investing only a portion of their human capital productively so that society bears a loss due to

[7] We assume a linear production function to simplify the analysis and notation. We could allow for societal output to be any increasing function of the amount of human capital that is invested in production without altering our results.
[8] We assume that human capital that is expended in corruption does not contribute to societal output purely to simplify the notation. We could allow for human capital that is expended in corruption to contribute to societal output, but less than human capital that is invested productively, without altering any of our results.

corruption.[9] Note that, since individuals' corruption levels $\{a_{i,j}^t\}$ are *unobservable*, their respective *actual* contributions to societal output are also unobservable.

We now describe individuals' payoffs from corruption. If an individual j carrying out activity i chooses corruption level $a_{i,j}^t \in [0,1]$, his *relative* or *quasi* share of societal output changes from

(2.5) $$w_i^t \to w_i^t + 1_{\{S_{i,j}=0\}} a_{i,j}^t p_i^t - 1_{\{S_{i,j}=1\}} \Lambda(a_{i,j}^t) w_i^t$$

Each individual's *actual share* of societal output is his relative share divided by the sum of the relative shares of all individuals. By (2.5), each individual's actual share of societal output is, therefore,

(2.6) $$f_{i,j}^t = \frac{\left(w_i^t + 1_{\{S_{i,j}=0\}} a_{i,j}^t p_i^t - 1_{\{S_{i,j}=1\}} \Lambda(a_{i,j}^t) w_i^t\right)}{\left[\sum_{k=1}^{n}\sum_{l=1}^{g_k^t} \left(w_k^t + 1_{\{S_{k,l}=0\}} a_{k,l}^t p_k^t - 1_{\{S_{k,l}=1\}} \Lambda(a_{k,l}^t) w_k^t\right)\right]}$$

In (2.5) and (2.6), the variables $\{S_{i,j}\}; i=1,...,n;\ j=1,...,g_i^t$ are binary random variables taking the value one when the agent fails or is "caught" engaging in corruption (for simplicity, we assume that these variables are independent across agents).[10] Hence, an agent's relative and actual shares of societal output could either increase or decrease representing the fact that corruption is a *risky* activity. From (2.5) and (2.6), if an agent carrying out activity i chooses a nonzero corruption level, his expected relative share of societal output increases with his power p_i^t. Hence, more powerful individuals reap greater benefits from corruption, *ceteris paribus*. Since agents in a particular activity i are identical, the variables $\{S_{i,j};\ j=1,...,g_i^t\}$ are identically distributed for each $i \in \{1,...,n\}$. The function $\Lambda(.):[0,1] \to [0,\infty)$ in (2.6) is an increasing, convex function with $\Lambda(0)=0$. If an agent fails in corruption, he incurs a penalty which is proportional to his honest share and increases with his level of corruption. Hence, richer individuals with higher honest or "promised" wages incur greater costs in terms of a reduction in their relative shares if they fail in corruption.

[9] Lui (1985) shows that corruption could sometimes be beneficial as it might mitigate the distortions created by *existing* government regulations.

[10] 1_A is the indicator function of set A.

If the agents choose corruption levels $\{a^t_{k,l}\}$, it follows from (2.4)-(2.6) that the payoff of an agent j carrying out activity i is:

$$x^t_{i,j}(\{a^t_{k,l}\}) = f^t_{i,j}(\{a^t_{k,l}\})Y^t \tag{2.7}$$

where Y^t is given by (2.4) (recall that we drop the subscript indicating the dependence of output on individuals' corruption choices). Hence, each individual's payoff from corruption depends, in general, on the corruption levels chosen by other individuals.[11]

We define the *societal corruption level* h^t in period t as

$$h^t = \left(\sum_{i=1}^{n} \sum_{j=1}^{g_i^t} a^t_{i,j} v^t_i \right) / \sum_{i=1}^{n} g^t_i v^t_i = \tag{2.8}$$

From (2.2) and (2.4), the economic output of society at the end of the period is

$$Y^t = \overline{Y}^t \left[1 - h^t \right] \tag{2.9}$$

Therefore, the societal corruption level h^t directly measures the proportional loss in societal output from its maximum possible level $\overline{Y}^t$ due to corruption. It follows from (2.9) that, in any period, corruption minimization and output maximization are equivalent objectives.

III. The Equilibrium

Individuals choose their corruption levels at the beginning of the period to maximize their expected end-of-period payoffs. Our basic setup describes a game in which each individual's strategy is to choose his level of corruption rationally anticipating the levels of corruption chosen by other individuals. For a general society, it is necessary to allow individuals to choose mixed strategies to ensure the existence of Nash equilibrium. We can use standard arguments (see Myerson, 1992) to show the existence of Nash equilibrium in mixed strategies.

In this study, we primarily focus on large societies where the application of the "large population" approximation permits an explicit characterization of the unique *pure strategy* Nash equilibrium of the corruption game. For a large population, it is reasonable to assume that an individual's choice of corruption

[11] Andvig and Moene (1990) argue that corruption across society affects an individual's propensity for corruption.

level has a negligible effect on societal economic output. Therefore, for a large population, we can replace (2.4), (2.6), and (2.7) by

(3.1)
$$x_{i,j}^{t}(\{a_{k,l}^{t}\}) = f_{i,j}^{t}(\{a_{k,l}^{t}\})Y^{t} = \frac{\left(w_i^t + 1_{\{S_{i,j}=0\}} a_{i,j}^{t} p_i^t - 1_{\{S_{i,j}=1\}} \Lambda(a_{i,j}^{t}) w_i^t\right)}{\sum_{k=1}^{n}\sum_{l=1}^{g_k^t} 1_{(i,j)\neq(k,l)} \left(w_k^t + 1_{\{S_{k,l}=0\}} a_{k,l}^{t} p_k^t - 1_{\{S_{k,l}=1\}} \Lambda(a_{k,l}^{t}) w_k^t\right)} Y^t$$

(3.2)
$$Y_{\{a_{k,l}\}}^{t} = \sum_{k=1}^{n}\sum_{l=1}^{g_k^t} 1_{(i,j)\neq(k,l)} [(1-a_{k,l}^{t}) v_k^t]$$

Notice that (3.2) and the denominator in (3.1) do not depend on the expressions involving individual j engaging in activity i. This reflects the "large population" approximation. For simplicity and concreteness, we henceforth assume that the "penalty function" $\Lambda(.)$ is given by

(3.3)
$$\Lambda(v) = \frac{1}{2} k v^2; v \in [0,1]; k > 0$$ [12]

The following proposition describes the unique Nash equilibrium in *pure strategies* for the large-population corruption game defined by (3.1)-(3.3).

Proposition 3.1 *For given productivities* $(v_1^t,...,v_n^t)$ *of the activities, power levels* $(p_1^t,...,p_n^t)$, *and honest shares* $\{w_1^t,...,w_n^t\}$ *of agents, all agents involved with an activity* $i \in \{1,....,n\}$ *choose the corruption level (we drop the second subscript denoting the agent)*

(3.4)
$$a_i^{t*} = \min\left(\frac{q_i}{1-q_i}\frac{p_i^t}{k w_i^t}, 1\right).$$

In (3.4), $q_i \in (0,1)$ *is the probability of success in corruption of agents engaged in activity* i.

From (3.4), an agent's equilibrium choice of corruption level a_i^{t*} increases with his power p_i^t, increases with his likelihood $\frac{q_i}{1-q_i}$ of succeeding in corruption, and decreases with his honest share w_i^t. These

[12] We could allow for the penalty function to be $\Lambda(x) = wx^q; w > 0, q > 1$, but this complicates the notation without qualitatively altering the key economic implications of our study.

results are intuitive because an agent's relative share of societal output increases with his power and his probability of success, while his penalty if he fails in corruption, increases with his honest share.

Our subsequent analysis depends only on the expression (3.4) for equilibrium corruption levels. Without loss of generality, we simplify the notation by re-defining the power variables $\{p_i^t\}$ so as to incorporate the term $\frac{q_i}{1-q_i}\frac{1}{k}$. Individual corruption levels in equilibrium are then given by

(3.5) $$a_i^{t*} = \min(\frac{p_i^t}{w_i^t}, 1)$$

IV. Compensation, Power, Inequality, and Corruption

In this section, we *fix* the productivities $\{v_i^t\}$ of the n activities and study how the distribution of agents $\{g_i^t\}$ across activities, the *productivity distribution*, and the *distribution of power* $\{p_i^t\}$, affect societal corruption and output. Throughout, we consider societies where power levels lie in the interval $[0, p_{\max}] \subset [0, \infty)$. The productivities of the least and most productive activities are denoted by $v_{\min}^t, v_{\max}^t$, respectively.

A. Societal Compensation Structure and Corruption

For a given productivity distribution $\{g_i^t\}$ and distribution of power $\{p_i^t\}$, we first derive the honest shares $\{w_i^t\}$ that minimize societal corruption and maximize output. Without any restrictions on parameters, an individual's corruption choice (3.5) might equal one so that the individual is *maximally* corrupt. For tractability, we avoid such scenarios in our subsequent analysis by imposing the following condition, which is sufficient to ensure that no agent in the society is maximally corrupt (see the proof of Proposition 4.1):[13]

[13] Note that, by (2.4), a maximally corrupt individual makes no contribution to societal output. Moreover, because power levels, productivities, and honest shares are observable, such a maximal corruption choice can be rationally anticipated *ex ante*. Societal output could, therefore, be increased by eliminating such individuals entirely from the societal production process and redistributing output among agents who make nonzero contributions to societal output. Hence, a society with maximally corrupt agents cannot be optimal from the standpoint of output maximization.

(4.1) $$Np_{\max}\sqrt{v_{\max}^t / v_{\min}^t} < 1$$ [14]

For *given* productivity and power distributions, the following result derives the output-maximizing (corruption-minimizing) honest shares of agents across society.

Proposition 4.1 *a) For a given productivity distribution* $\{g_i^t\}$ *and distribution of power* $\{p_i^t\}$*, societal corruption is minimized and output is maximized when*

(4.2) $$w_i^t = l^t \sqrt{v_i^{t\prime} p_i^t}$$

where $l^t = \left(\sum_{j=1}^{n} g_j^t \sqrt{v_j^{t\prime} p_j^t} \right)^{-1}$. *In (4.2),* $v_i^{t\prime} = \dfrac{v_i^t}{\sum_{j=1}^{n} g_j^t v_j^t}$ *is the* ***relative productivity*** *(maximum output as a proportion of maximum societal output) of an agent carrying out activity* i.

b) Under the compensation structure (4.2), the individual and societal corruption levels are given by

(4.3) $$a_i^t = \frac{1}{l^t}\sqrt{\frac{p_i^t}{v_i^{t\prime}}} \quad \textit{and}$$

(4.4) $$h^t = \left(\sum_{j=1}^{n} g_j^t \sqrt{v_j^{t\prime} p_j^t} \right)^2$$

From (4.2), we see that societal output is maximized when, controlling for productivity, honest shares increase with relative power. This prediction is consistent with the empirical evidence in studies such as van Rijckeghem and Weder (2001). (4.2) also implies the intuitive result that, controlling for power, honest shares increase with relative productivity under the output-maximizing compensation structure. The individual corruption levels given by (4.3) also lead to the intuitive implications that, controlling for productivity, individual corruption levels increase with power and, controlling for power, individual corruption levels decline with relative productivity.

Note that, since individuals' corruption levels and their respective actual contributions to realized societal output are *unobservable*, *contingent* compensation is not feasible (that is, compensation contingent on

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[14] Since $\sum_{i=1}^{n} g_i^t w_i^t = 1$ and $\sum_{i=1}^{n} g_i^t = N$, w_i^t is, in general, $O(1/N)$ for each i (recall that a variable x is $O(1/N)$ if $\lim_{N\to\infty} Nx < \infty$). By (2.5) p_i^t is also, in general, $O(1/N)$ for each i, and $v_{\max}^t / v_{\min}^t$ is $O(1)$. Hence, $Np_{\max}\sqrt{v_{\max}^t / v_{\min}^t}$ is $O(1)$ so that (4.1) is a reasonable condition to impose on the parameters.

an individual's actual contribution to output). Therefore, the only feasible compensation scheme is one where individuals receive honest shares $\{w_i^t\}$ *ex ante* rationally anticipating their *ex post* choices of corruption levels. Hence, (4.4) is the *minimum attainable societal corruption level* for *given* productivity and power distributions.

B. The Effect of the Distribution of Power on the Output-Maximizing Compensation Structure

The societal power distribution is the relation between the levels of power and the productivities of the activities in the economy. Keeping the productivity distribution $\{g_i^t\}$ and the power $\overline{p}^t$ associated with the "average" activity with productivity equal to the per-capita maximum output $v_{ave}^t = \left(\sum_{i=1}^{n} g_i v_i^t\right)/N$ *fixed*, we now investigate the effects of varying power distributions on the output-maximizing compensation structure and the minimum attainable societal corruption level. In this study, we adopt the philosophical position that a society's power distribution is "sticky" and that countries could have differing power distributions that need not be optimal from the standpoint of output maximization. *Given the distribution of power,* however, the compensations of agents in a society are determined to maximize output rationally incorporating their *ex post* choices of corruption levels. In other words, the time horizon over which the societal compensation structure could be altered is much smaller than the horizon over which its distribution of power could be altered. We believe that this position is plausible because a country's power distribution is largely determined by its political and legal institutions that are difficult to change significantly over short time horizons, while the wages of individuals could be significantly altered over time.

For analytical convenience, we consider the following class of power distributions:

(4.5) $$p_i^t = \overline{p}^t \left(\frac{v_i^t}{v_{ave}^t}\right)^m \forall i = 1,,.n; \quad \text{where } m \in R$$

Note that $\overline{p}^t$ is the power associated with the "average" activity with productivity v_{ave}^t; it is *not* the average power of all activities. The various activities in an economy have, by their very nature, *nonzero* levels of power that could potentially be abused by agents. In particular, the power associated with these activities cannot be completely eliminated through law enforcement (note that, in our model of corruption across society, law enforcement itself constitutes a group of activities with associated levels of power that could be abused). In this context, the power $\overline{p}^t$ of the "average" activity captures the general *level* of nonzero returns from corruption in the society. By keeping $\overline{p}^t$ fixed in our analysis, we examine the effect of varying the "skew" or *bias* of the distribution of power, which is described by the parameter m, with respect to the power associated with the average activity.

From (4.5), we see that, if $m > 0$, power increases with productivity representing a society where more productive activities are associated with higher power. If $m < 0$, power decreases with productivity representing a society where more productive activities are associated with lower levels of power. For a perfectly equitable society with $m = 0$, all activities have the same power. Large and positive values of m correspond to power distributions where more productive activities are associated with disproportionately greater power, while large and negative values of m represent "highly inverted" power distributions where less productive activities are associated with disproportionately greater power. Although the class of power distributions (4.5) is far from general, it serves as an analytically convenient benchmark for the investigation of the distribution of power on societal corruption, output, the compensation structure, and inequality – the primary objectives of this study.

Since the maximum possible power p_i^t is $p_{\max}$, the *feasible range* of the bias parameter m is

(4.6) $$[m_{\min}^t, m_{\max}^t] \equiv [\frac{\ln(p_{\max} / \overline{p}^t)}{\ln(v_{\min}^t / v_{ave}^t)}, \frac{\ln(p_{\max} / \overline{p}^t)}{\ln(v_{\max}^t / v_{ave}^t)}],$$

where $v_{\min}^t, v_{\max}^t$ are the minimum and maximum productivities of activities in the economy. From (4.6), we note that, because, $p_{\max} \geq \overline{p}^t$ and $v_{\min}^t \leq v_{ave}^t = (\sum_{i=1}^{n} g_i^t v_i^t) / N \leq v_{\max}^t$,

(4.7) $$m_{\min}^t < 0, m_{\max}^t > 0$$

Since individual choices of corruption levels depend only on *relative productivities* (Proposition 4.1), it is convenient to re-express the power distribution (4.5) as:

(4.8) $$p_i^t = \overline{p}^t\left(\frac{v_i^t}{v_{ave}^t}\right)^m = \overline{p}^t\left(\frac{v_i^t / \sum_{i=1}^n g_i^t v_i^t}{v_{ave}^t / \sum_{i=1}^n g_i^t v_i^t}\right)^m = \overline{p}^t (N v_i^t{}')^m$$

The last equality in (4.8) follows from the fact that the average productivity is $v_{ave}^t = (\sum_{i=1}^n g_i^t v_i^t)/N$.

The following result describes how the societal power distribution described by the bias m in (4.8) affects the output-maximizing compensation structure and the corresponding minimum attainable societal corruption level. Its proof follows directly from (4.8) and the result of Proposition 4.1 and is omitted.

Proposition 4.2 *a) Fix the productivity distribution* $\{g_i^t\}$ *and the power* $\overline{p}^t$ *associated with the average activity with productivity equal to the per-capita maximum output* v_{ave}^t. *For any bias* $m \in [m_{\min}^t, m_{\max}^t]$ *of the societal power distribution, the compensation structure*

(4.9) $$w_i^t = l_{(1+m)/2}^t \sqrt{N^m \overline{p}^t}\,(v_i^t{}')^{(1+m)/2};\ i = 1,\ldots,n \quad ,$$

maximizes societal output where $l_{(1+m)/2}^t = \left(\sqrt{N^m \overline{p}^t} \sum_{i=1}^n g_i^t (v_i^t{}')^{(1+m)/2}\right)^{-1}$.

b) Under the compensation structure (4.9) individual corruption levels are given by

(4.10) $$a_i^t{}^* = \frac{\sqrt{N^m \overline{p}^t}\,(v_i^t{}')^{(m-1)/2}}{l_{(1+m)/2}^t} < 1;\ i = 1,\ldots,n$$

The corresponding societal corruption level is given by:

(4.11) $$h^t{}^*(m) = N^m \overline{p}^t \left(\sum_{i=1}^n g_i^t (v_i^t{}')^{\frac{m+1}{2}}\right)^2$$

By (4.9), the output-maximizing compensation structure is increasing and strictly convex if $m > 1$, that is, more productive agents receive *disproportionately* greater honest shares. If $-1 < m < 1$, then the output-maximizing compensation structure is increasing and strictly concave. Finally, for a highly inverted power distribution where $m < -1$, the output-maximizing compensation structure is actually decreasing. The results of Proposition 4.2, which relate the output-maximizing compensation structure to the distribution of power, could be viewed as *positive* implications of our theory (see the discussion at the beginning of Section IVB).

The intuition for these results hinges on the fact that societal corruption is minimized when the marginal change in corruption level, with respect to the honest share weighted by the productivity of the activity, is uniform across activities. It follows from (3.5) that, if more productive activities are associated with disproportionately greater power, individuals engaged in such activities also receive *disproportionately* greater honest shares under the output-maximizing compensation structure in order to mitigate their enhanced incentives for corruption. On the other hand, if power is increasing and concave in productivity, *or* declines with productivity with the bias of the power distribution being above a threshold, more productive individuals receive greater honest shares, but the honest shares are *less than proportional* to productivity. Finally, for a highly inverted power distribution that is heavily biased in favor of the less productive activities, honest shares actually decline with productivity in order to mitigate the widespread abuse of power or "petty corruption" by agents engaged in less productive activities. In general, an increasingly convex (concave) compensation structure exacerbates corruption among less productive (more productive) agents relative to more productive (less productive) ones. Depending on the bias of the power distribution, the tradeoff between "high-level" and "petty" corruption is optimally balanced for a society where more productive agents receive either greater or less than proportionate honest shares.

Consistent with the intuition described above, the result of part b) of Proposition 4.2 shows that, under the output-maximizing compensation structure, individual corruption levels increase (decrease) with productivity if the bias of the power distribution is greater (less) than one. In other words, there is relatively greater (less) "high-level" compared with "petty" corruption. This observation is central to understanding the intuition for our subsequent results describing the variation of corruption with inequality.

By the intuition described above, the basic insights that the bias of the power distribution affects the "skew "of the output-maximizing compensation structure, and the relative predominance of high-level and petty corruption, are likely to be valid for more general power distributions. The results of Propositions 4.1 and 4.2 contribute to the literature pioneered by studies such as Becker and Stigler (1974), Besley and McLaren (1993), Mookherjee and Png (1995), and Acemoglu and Verdier (2000). Specifically, our analysis describes how individuals *across society* are compensated *relative* to their productivities and power.

C. Inequality and Corruption

Our results thus far do not depend on the productivity distribution $\{g_i^t\}$. We now examine how "inequality" in this distribution affects societal corruption *for a given power distribution* described by the bias

m as in (4.5) and (4.8). As discussed in Section IVB, for given productivity and power distributions, the compensation structure is assumed to maximize societal output so that honest shares are given by (4.9).

Following the literature on the "economics of uncertainty", we measure inequality in the productivity distribution using the notion of "second order stochastic dominance" (Huang and Litzenberger 1988). Specifically, if $g(.), h(.)$ are any two productivity distributions, then $g(.)$ is "more unequal" than $h(.)$ (denoted $g \succ h$) if and only if $g(.)$ is "second order stochastically dominated" by $h(.)$. The following proposition then describes the relation between societal corruption and inequality in the productivity distribution.

Proposition 4.3 *Fix the bias* $m \in [m^t_{\min}, m^t_{\max}]$ *of the societal power distribution. If* $g(.), h(.)$ *are two productivity distributions with* $g \succ h$, *let* h^t_g*, h^t_h* *be the corresponding minimum attainable societal corruption levels defined in Proposition 4.2.*

a) If $m = 1$ *then* $h^t_g* = h^t_h*$, *that is, societal corruption (output) is unaffected by inequality.*

b) If $m > 1$ *then* $h^t_g* > h^t_h*$, *that is, societal corruption increases with inequality.*

c) If $-1 < m < 1$, *then* $h^t_g* < h^t_h*$, *that is, societal corruption decreases with inequality.*

d) If $m < -1$, *then* $h^t_g* > h^t_h*$, *that is, societal corruption increases with inequality.*

The intuition for the above results can be understood from the results of Propositions 4.2 (b). In a society where $m = 1$, power is proportional to productivity. In this case, all agents choose the same corruption level so that societal corruption is equal to the individual corruption level, which does not vary with the productivity distribution. If power is increasing and convex in productivity, the society has relatively greater levels of high-level corruption compared with petty corruption and individuals' contributions to the societal corruption level are *convex* in productivity. Hence, societal corruption increases with inequality in the productivity distribution. If power is increasing and concave in productivity, or declines with productivity with the bias of the power distribution being above a threshold, individual corruption levels decrease with productivity leading to a society that is characterized by relatively greater "petty" corruption. In this scenario, the contribution to societal corruption is *concave* in productivity so that societal corruption decreases with inequality. Finally, if the bias of the power distribution is below the threshold, the contribution to societal corruption is *convex* and *decreasing* in productivity so that societal corruption again increases with inequality.

Hence, depending on the bias of the power distribution, the relation between societal corruption and inequality could be positive or negative.

The results of Proposition 4.2 have been derived using the class of power distributions (4.5). As in the case of Proposition 4.2, however, the intuition described above suggests the key implication that the relation between societal corruption and inequality could be positive or negative depending on the distribution of power is more generally valid. The distribution of power affects individual choices of corruption levels and, therefore, the relative predominance of high-level and petty corruption in society, which in turn influences the relation between societal corruption and inequality.

We now use the result of Proposition 4.3 to examine the variation of societal corruption with *income* inequality for a fixed power distribution. This necessitates relating inequality in the productivity distribution to income inequality. For concreteness, we assume that the productivity distribution is *symmetric* about the "average" activity with the mean productivity v^t_{ave}. Within the class of such distributions, it is easy to show that one productivity distribution "second order stochastically dominates" another if and only if its *coefficient of variation* is lower.

Empirical analyses of the relation between corruption and income inequality typically use statistics such as the Gini coefficient or the coefficient of variation to measure "inequality". Further, the publicly available income data used by these studies are likely to include only "reported" or legal income. Therefore, in the following, we measure "income inequality" by the "coefficient of variation" of the distribution of promised "honest income". Recall that the income of an individual engaged in activity i *as a proportion* of societal output in an *honest society* is the honest share w^t_i. As in Section IVB, for given population and power distributions, the honest shares $\{w^t_i\}$ are chosen to maximize societal output and are, therefore, given by (4.9).

Figure 1 displays the variation of societal corruption with the coefficient of variation of the distribution of honest shares for different values of the bias m of the power distribution (see 4.5 and 4.8). In these simulations, we assume that the productivity distribution is *triangular* and symmetric about the per capita maximum output v^t_{ave} (the implications are qualitatively unchanged for other choices of symmetric distributions). Keeping the per capita maximum output v^t_{ave} fixed, we vary the standard deviation of the productivity distribution and numerically calculate the coefficients of variation of the honest shares (from 4.9) and the societal corruption levels (from 4.11) for different values of the bias m of the power distribution.[15]

From the figures, we note that, when $m > 1$, societal corruption increases with inequality in the distribution of honest income. If $m \in (-1,1)$, societal corruption decreases with honest income inequality. Finally, if $m < -1$, societal corruption varies non-monotonically with honest income inequality. Hence, the relation between societal corruption and income inequality also crucially depends on the power distribution. These findings suggest that, in empirical analyses of the relation between corruption and inequality based on cross-country data, it is important to appropriately control for the characteristics of the society's power distribution.

D. Variation of Societal Corruption with the Distribution of Power

In Section B, we derived the output-maximizing (corruption minimizing) compensation structure and the corresponding minimum attainable societal corruption level for a *given* societal power distribution described by (4.5). We now *fix* the productivity distribution and examine how the minimum attainable societal corruption level varies with the power distribution. As discussed in Section IVB, for given productivity and power distributions, the societal compensation structure is chosen to maximize output (rationally anticipating individuals' ex post choices of corruption levels) and is, therefore, given by (4.9). We use the result of the following lemma in our main result.

Lemma 4.1 *The function*

(4.12) $$w^t(y) = \frac{1}{\sqrt{N}} \sum_{i=1}^{n} g_i^t \left(N v_i^t{}' \right)^y$$

is a convex function of $y \in R$ *and attains a unique minimum at* $y^t{}^* \in (0,1)$.

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[15] The population N of the society is set to one thousand in our simulations (none of our results is affected by the actual population of the society). The range of productivities $[v^t_{\min}, v^t_{\max}]$ is set to $[500, 1500]$. The power level $\overline{p}^t$ associated with the "average" activity with productivity equal to the per-capita maximum output 1000 is set to 0.0006 in each period (recall from footnote 13 that the power levels are $O(1/N)$). Note that condition (4.1) is satisfied by these parameters.

The following result describes the variation of societal corruption with the bias of the power distribution.

Proposition 4.4 *Fix the productivity distribution* $\{g_i^t\}$ *and the power* $\overline{p}^t$ *associated with the average activity with productivity equal to the per-capita maximum output* v_{ave}^t. *For each value* m *of the bias of the power distribution, let* $h^t*(m)$ *be the minimum attainable societal corruption level given by (4.11).*

a) $h^t*(m)$ *is strictly convex and varies non-monotonically in an (approximately) U-shaped manner with* $m \in [m_{\min}^t, m_{\max}^t]$.

b) Societal output is maximized when the bias m^t* *of the societal power distribution is:*

$$m^t* = \max(2y^t*-1, m_{\min}^t) \qquad \text{if} \quad 2y^t*-1 \le m_{\max}^t \tag{4.13}$$

$$m^t* = m_{\max}^t \qquad \text{if} \quad 2y^t*-1 > m_{\max}^t$$

where y^t* *is defined in Lemma 4.1.*

c) The output-maximizing bias $m^t* \in (-1,1)$. *The corresponding societal compensation structure is given by (4.9) with* $m = m^t*$ *and is increasing and strictly concave.*

d) If

$$\sum_{i=1}^{n} g_i^t \sqrt{\frac{v_i^t}{v_{ave}^t}}\left(\ln\left[\frac{v_i^t}{v_{ave}^t}\right]\right) > 0; \quad m^t* \in (-1,0);$$

$$\sum_{i=1}^{n} g_i^t \sqrt{\frac{v_i^t}{v_{ave}^t}}\left(\ln\left[\frac{v_i^t}{v_{ave}^t}\right]\right) < 0; \quad m^t* \in (0,1); \tag{4.14}$$

Proposition 4.4 implies that societal corruption varies *non-monotonically* in a U-shaped manner with the bias of the power distribution (keeping the power associated with the "average" activity fixed). By the results of parts c) and d), *depending on the productivity distribution*, power could either increase with, decrease with, or stay constant with productivity under the output-maximizing power distribution (within the class of power distributions described by (4.5) and (4.8)). The conditions (4.14) describe the productivity distributions for which the corruption-minimizing distribution of power is increasing, decreasing, or constant. Intuitively, the first (second) condition in (4.14) holds if the relative proportion of agents engaged in more productive activities is above (below) a threshold. Since $m^t* \in (-1,1)$, it follows from (4.10) that individual corruption levels *decline* with productivity under the output-maximizing power distribution so that the society is characterized by relatively greater petty corruption compared with high-level corruption. Consequently, as stated in part c) of the proposition, the compensation structure is *increasing* and *strictly concave*.

The intuition for the above results hinges on the fact that the attractiveness of high-level corruption *relative* to petty corruption increases with the bias of the power distribution (see 4.10). For large and positive biases, societal corruption is high due to greater high-level corruption; for highly inverted power distributions with large and negative biases, societal corruption is again high due to widespread petty corruption. The output-maximizing power distribution balances the tradeoff between high-level and petty corruption. If the relative proportion of agents engaged in more productive activities is above (below) a threshold, deadweight losses due to high-level (petty) corruption are costlier so that power decreases (increases) with productivity under the output-maximizing power distribution. The societal corruption level is the average of individual corruption levels weighted by the relative productivities of the activities (see 2.7). Under the corruption-minimizing power distribution, therefore, individual corruption levels decline with productivity so that petty corruption is relatively predominant in the "optimal" society. By the intuition for Proposition 4.2, the corresponding societal compensation structure is, therefore, increasing and strictly concave.

The intuition described above suggests that the central insights of Proposition 4.4 ---- the output-maximizing distribution of power optimally balances the tradeoff between high-level and petty corruption, and that the distribution of agents across activities affects the nature of the output-maximizing power distribution ---- are more generally valid.

As discussed earlier, the distribution of power in society is likely to be significantly affected by the legal system that detects, prevents, and prosecutes illegal corrupt activities. In particular, the typical legal system does not affect all individuals in the same manner. In this context, Proposition 4.4 has the normative implication that, if a relatively larger proportion of the population is engaged in more productive (less productive) activities, the legal system should target high-level (petty) corruption. Hence, high-level corruption should be targeted in highly productive, developed economies where relatively larger proportions of the population are engaged in more productive activities, while petty corruption should be targeted in developing economies.

Proposition 4.4 also has interesting implications for the effect of the relative power of the public sector on societal corruption. Under the assumption that the productivity of the public sector is lower (on average) than the private sector (we demonstrate empirical support for this implication in Section V), a possible proxy for the bias m of the power distribution is the relative power of the private sector vis-à-vis the public sector. For negative (positive) values of m, corruption in the society is dominated by public (private) sector corruption. Corruption is minimized when the effects of private and public sector corruption are optimally balanced. In this context, Proposition 4.4 implies that if the relative proportion of the population in the public sector is above (below) a threshold, societal corruption is minimized when the private sector is relatively more (less) powerful. Therefore, these findings shed light on the reasons why developed economies with large proportions of productive agents like Finland and Canada have very low corruption levels *and* relatively powerful public sectors (Bardhan, 1997) while undeveloped dictatorships in Africa in which most (if not all) power is in government hands have very high corruption levels. From a normative standpoint, our results support the prevailing consensus that government power and intervention should be lowered to improve economic performance in developing economies, but also imply that private sector power should be lowered in developed economies in order to mitigate "high level" expropriation.

Insofar as the power distribution is significantly influenced by the political and legal institutions in the society, the results of Sections IVA-D suggest that the society's institutional features are key determinants of the compensation of individuals across society, individual and societal corruption levels, the relation between corruption and inequality, and economic output. In Section VI, we show that the distribution of power also plays a pivotal role in determining the *evolutions* of corruption and output.

V. Empirical Analysis

The results of Propositions 4.2 and 4.4 also lead to a novel, *empirically testable* implication for the relation between societal corruption and the relative level of public sector wages. By (4.9), as the bias of the power distribution increases, the output-maximizing compensation structure becomes increasingly skewed in favor of the more productive activities; that is, the compensation of individuals engaged in less productive activities declines *relative* to the compensation received by individuals engaged in more productive activities. If the private sector is more productive *on average* than the public sector, this implies that the average level of public sector wages *relative* to the per-capita compensation in the economy declines with the bias of the power distribution. The prediction that societal corruption varies in a non-monotonic *U-shaped manner* with the bias of the power distribution (Proposition 4.4), therefore, implies that societies with very low *or* very high *relative levels* of public sector wages are more corrupt than those with intermediate relative levels. Therefore, we arrive at the following testable hypothesis:

Hypothesis: *Societal corruption varies in a roughly U-shaped manner with the average public sector wage relative to the per-capita income.*

We use regression analysis and cross-country data on corruption to empirically test and confirm the validity of this hypothesis.[16]

Before testing the hypothesis, however, we empirically examine the underlying premise that the private sector is more productive on average than the public sector. We use data compiled by the Groningen Growth and Development Center (http://www.ggdc.net/index.html) on the per-capita labor productivities in 60 industries for 26 OECD countries. **Table 1** displays the average per-capita labor productivities for private sector industries in the database, and in *public administration* and *defense*, for each country. We find that, for every country except Poland, the average labor productivity per person across industries in the private sector is substantially greater than the average labor productivity per person in public administration and defense. Based on these data, we can reject the null hypothesis that the ratio of the per capita labor productivity in the private sector to the per-capital labor productivity in public administration is less than one. We now proceed with the tests of our primary hypothesis.

A. Data and Methodology

The dependent variable in our analysis is Transparency International's *Corruption Score* for the year 2004. Alternatively average corruption over the last 5 years could be used; the correlation between these two alternative measures is 0.98. We use the 2004 scores since they are available for a larger number of countries. Transparency International's corruption score for each country is an aggregate measure of various aspects of corruption including its general level, its spread in public and private business, and the estimated losses caused by corruption. The scores are compiled using the results of surveys of domestic and expatriate business people,

[16] In our framework, agents' honest shares $\{w_i^t\}$ are determined *ex ante* in each period rationally anticipating their *ex post* corruption choices. Agents' remunerations, therefore, determine the *ex post* incidence of corruption in the society.

economic risk analysts, and country experts. We adjust these scores so that they take values from 0 (least corrupt) to 10 (most corrupt).

The primary independent variable of interest is the *Average Government Wage as a Proportion of Per Capita GDP* over the period 1996-2000 obtained from the World Bank dataset "Cross-National Data on Government Employment and Wages" (our results are qualitatively unchanged if we instead choose, as the independent variable, the average government wage as a proportion of per capita GDP over the earlier period 1991-1995 or over the entire decade 1991-2000).

We test the relation between societal corruption and the average government wage relative to per capita GDP, controlling for several other variables that have been identified in prior literature as important determinants of corruption. These include the *percentage of the population that was Protestant* in the year 1980 (data obtained from Treisman, 2000), the *proportion of fuels, metals, and minerals in a country's merchandise exports* in the year 1993 (data obtained from Treisman, 2000), and the *percentage of imports in the country's GDP* for the year 1999 (data obtained from the Penn World Table 6.1, Heston *et al* 2002). We also include a dummy variable each for (1) *democracy* – indicating if the country was a continuous democracy from 1950 to 2000 (data obtained from Treisman, 2000 and Freedom House (http://www.freedomhouse.org/reports/century.html)); (2) whether the country was a *British Colony*; (3) whether the country has a *federal* political structure (*Handbook of Federal Countries: 2002*, Montreal and Kingston: McGill-Queen's University Press, 2002); (4) whether the country has a *common law* system.

Finally, we include the country's average *per capital GDP* over the period 1980-1990 (Penn World Table 6.1, Heston et al 2002) as an additional control variable. By (2.7) and (2.9), corruption negatively affects output. Hence, we measure output over a period 1980-1990 that is significantly earlier than the year 2004 where corruption is measured so that potential endogeneity problems arising from the use of contemporaneous measures of corruption and output are mitigated. We present the results of tests including and excluding this variable.

B. Results

Table 2 presents descriptive statistics for our dependent and independent variables. Recall that 2004 Transparency International Corruption scores are adjusted so that they range from 0 (least corrupt) to 10 (most corrupt). **Table 3** reports the correlation matrix between the independent variables in the analysis. As expected, and noted by Treisman (2000), the *Common Law* and *British Colony* dummies have a high positive correlation.

Table 4 presents the results of OLS regressions with different model specifications. The number of observations differs across the models because data for all the independent variables are not available for all countries. Model specifications 1a, 2a and 3a differ from specifications 1, 2, and 3 respectively by including *Log Prior Average Per Capita GDP* as an additional control variable. Model 2 includes the *Protestant* and *Common Law* variables in addition to the independent variables of Model 1, and Model 3 adds the share of *Fuels, Metals and Minerals* in a country's merchandise exports (its importance as a potential determinant of corruption is emphasized by Ades and Di Tella 1999). In all models, we include the *Prior Relative Government Wage* and the *Prior Relative Government Wage*^{2} as independent variables to test for a non-monotonic U-shaped relation between corruption and the relative level of government wages.

In all specifications, the coefficient of *Prior Relative Government Wage*^{2} is positive and significant at the 5% level consistent with the predicted U-shaped relation between corruption and the relative level of government wages. The coefficient on the linear term *Prior Relative Government Wage* is significant at the 5% level in all specifications except 1 (a) where it is significant at the 6% level. From the estimated coefficients of the three models in Table 2, we see that as the *Prior Relative Government Wage* varies, *ceteris paribus*, societal corruption attains a minimum when the *Prior Relative Government Wage* ranges between 2.3 and 2.6, which is well within the observed range of the variable in our data (see Table 2). Figure 2 shows the distribution of the scatter plot of the residuals from a regression of corruption from all variables in model 3, except *Prior Relative Government Wage* and (*Prior Relative Government Wage)*^{2} against the *Prior Relative Government Wage* variable. The figure displays the U-shaped relation between corruption and the relative government wage.

The coefficients of the control variables also have signs that are consistent with those reported in prior studies. There is a strong negative effect of past output on current corruption levels as evidenced by the negative and significant coefficients of *Log Prior Average Per Capita GDP* (Treisman, 2000). Corruption is reduced by the presence of democracy and the openness of the economy as measured by the share of imports in GDP. Protestant countries witness lower corruption (Ades and Di Tella, 1999, Treisman, 2000). However, the effects of the proportion of fuel, metals and minerals in a country's merchandise exports, a federal political structure, a common law system, and a British colonial history are generally insignificant in the different specifications.

In summary, the results of our empirical analysis provide substantial support for the testable implications of our theory while remaining generally consistent with prior empirical evidence.

VI. The Evolution of Corruption and Output

Our analysis thus far has focused on the interplay among societal corruption, the compensation structure, the distribution of power, and the productivity distribution in a specific, representative time period $[t, t+1]$. We now explore the variation of societal corruption and output over time. Our focus is on the effects of the *relative* productivities of the various activities in the economy and the distribution of power on corruption. We, therefore, abstract from the effects of human capital growth by assuming that the human capital of agents carrying out each activity $i \in \{1,\ldots,n\}$ as well as the numbers of agents carrying out the various activities are invariant over time, that is,

(6.1) $$h_i^{t+1} = h_i^t; \quad g_i^{t+1} = g_i^t$$

Henceforth, we drop the superscripts on these variables as well as the human capital variables.

By (2.1) and (2.4), when agents' equilibrium choices of corruption levels in period t are $\{a_i^t *\}$, the output of agents carrying out any activity j in period t is

(6.2) $$g_j[(1-a_j^t*)v_j^t] = g_j T_j^t\left[(1-a_j^t*)h_j\right].$$

Similar to "*learning by doing*" models (see Section 4.3 of Barro and Sala-i-Martin, 2004), we posit that human capital investments and production in any period lead to external "technology" or "knowledge" spillovers that influence output in *future* periods by affecting the evolution of the technology parameters $\{T_i^t\}$. Specifically, the technology parameters $\{T_i^t\}$, which are the marginal products of human capital, evolve from period t to period $t+1$ as follows:

(6.3) $$T_j^{t+1} = \Gamma[(1-a_j^t*)T_j^t + (a_j^t*)T_j^t y]; \quad \Gamma \geq 1, y \in (0,1).$$

In (6.3), Γ is a parameter representing technological growth due to external spillovers generated by human capital investments and production, which is assumed to be uniform across all activities for simplicity. From (6.3), we see that technological growth is lowered from its first-best level by the proportion of human capital that is expended in corruption. Hence, corruption has short-term and long-term detrimental effects; it not only reduces output in the current period, but also reduces output in future periods by hampering technological growth. From (2.1), (6.1), and (6.3), the productivities $\{v_i^t\}$ of the activities in the economy evolve as follows:

(6.4) $$v_j^{t+1} = \Gamma\left[(1 - a_j^t{}^*)v_j^t + (a_j^t{}^*)v_j^t y\right]$$

A. Evolution of a Society with a Fixed Power Distribution

We first examine the dynamics of societal corruption when the distribution of power is fixed over time and is given by (4.5) and (4.8), while the compensation structure in each period maximizes societal output (recall the discussion at the beginning of Section IVB). In period 0, we assume that the productivity distribution is *triangular* and *symmetric* about the per-capita productivity v_{ave}^0 (all our results are robust to alternative choices of symmetric distributions). The productivities of activities in successive periods are given by (6.4). For each value m of the bias of the power distribution, the honest shares of individuals in each period are chosen to maximize societal output and are, therefore, given by (4.9). The corresponding individual and societal corruption levels are given by (4.10) and (4.11), respectively. We use numerical simulations to illustrate the evolution of societal corruption and output; we extensively use the results of Section IV to describe the intuition for our findings.

Figures 3, 4, and 5 display the variations of societal corruption, the logarithm of per capita output, and the output growth rate over time for different choices of the bias of the societal power distribution.[17] The output growth rate over successive periods t and $t+1$ is defined as

[17] In all our simulations, the population N of the society is set to one thousand (none of our results is affected by the actual population of the society). The initial range of productivities $[v_{\min}^0, v_{\max}^0]$ is set to $[500, 1500]$. The initial distribution of agents is triangular and symmetric about the mean 1000. The power level $\overline{p}^t$ associated with the "average" activity with productivity equal to the per-capita maximum output 1000 is set to 0.0006 in each period (recall that the power levels are $O(1/N)$ where N is the population of the society). Note that condition (4.1) is satisfied by these parameter choices. The parameters Γ and y are set to 1.25 and 0.75, respectively.

(6.5) $$\text{Growth Rate}^{t} = \left(Y^{t+1} - Y^{t}\right)/\, Y^{t}$$

From the figures, we see that the dynamics of societal corruption, output per capita, and the growth rate of output vary dramatically with the bias of the power distribution. The results reported in Figures 3, 4, and 5, which are representative of all the results of all the simulations that we have carried out, suggest that the dynamics of corruption, output, and growth can be broadly classified into four distinct "regimes".

When the distribution of power is strictly convex so that its bias exceeds one, the society has endemically high corruption levels, which are stable over time. By the results of Section IV, these societies are characterized by significant high-level corruption since the highly productive activities are associated with disproportionately greater power. Per capita output and the growth rate steadily decline over time, representing the debilitating effects of high corruption levels.

When the power distribution is increasing and concave so that its bias is positive, but less than one, societal corruption is high, but declines gradually over time. In these societies, petty corruption is relatively more attractive than high-level corruption (see 4.10). Hence, by (6.4), the productivities of less productive activities declines relative to those of more productive ones, leading to an increase in the inequality of the productivity distribution. By the intuition underlying the result of Proposition 4.3(c), societal corruption declines. Although societal corruption declines gradually, it is still relatively high because of the presence of significant high-level corruption. Hence, the per capita output also declines, while growth rates are negative, but increase gradually over time.

When the power distribution is decreasing, but its bias is above a negative threshold, societal corruption declines significantly and per capita output levels and growth rates increase significantly over time. In these societies, high-level corruption is relatively unattractive and the productivities of the less productive activities decline relative to the more productive ones so that inequality in the productivity distribution *increases* over time. By the intuition underlying the result of Proposition 4.3 (c), societal corruption *decreases* with inequality in these societies so that corruption declines significantly over time, while the per-capita output and the growth rate increase significantly.

Finally, for highly inverted power distributions where the bias is below a negative threshold, societal corruption varies *non-monotonically* over time. Corruption initially decreases and then increases over time, while the per capita output initially increases along with declining societal corruption, but eventually becomes stable. The growth rate is highly unstable but eventually declines significantly over time. The highly inverted distributions of power in these societies lead to very high "petty" corruption levels, but very low high-level corruption. Societal corruption initially declines and output increases, because of insignificant high-level corruption. Since petty corruption is much more attractive, however, the productivities of the less productive activities decline substantially relative to those of the more productive ones so that inequality in the distribution of productivities rises substantially. By the intuition underlying the result of Proposition 4.3(d), petty corruption levels become prohibitively high so that societal corruption eventually begins to increase while the growth in per-capita output tapers off.

The figures clearly demonstrate that societies with differing power distributions can experience dramatically divergent evolutions of their corruption levels and output, thereby leading to substantial cross-sectional variation in corruption and economic performance across countries. Figures 3, 4, and 5 also demonstrate that, while the relation between societal corruption and the output growth rate is generally negative as documented by Mauro (1995), the *sensitivity* of this relation is significantly affected by the distribution of power. As emphasized by several previous studies (see the surveys by Bardhan 1997, Tanzi 1998), Figure 3 demonstrates that, depending on the distribution of power in the society, societal corruption could be highly persistent over time. Moreover, the history of corruption in the society that is itself dependent on the society's institutions through their effect on the distribution of power, significantly affects current corruption levels.[18]

B. Evolution of "Optimal" Society

We now examine the variation of societal corruption over time when, in each period, the societal compensation and power distributions are *both* chosen to maximize societal output (or minimize corruption). Given our philosophical position that societies could have differing power distributions that need not be "optimal" (output-maximizing) (recall the discussion in Section IVB), this investigation is *normative* in nature.

The values of the parameters are the same as in Figures 3, 4, and 5. **Figure 6** displays the evolution of societal corruption, the logarithm of per capita output, the growth rate, and inequality in the productivity distribution. The variables are scaled so that they can be conveniently represented on the same graph. From the

[18] Hauk and Saez-Marti (2002) show the persistence of corruption through its cultural transmission.

figure, we see that societal corruption declines significantly and per capita output and the growth rate increase significantly, over time. These findings further underline the importance of the underlying power distribution as a determinant of societal corruption and output. Societal output is dramatically improved if political and legal institutions that determine the society's distribution of power could be altered over time to reflect the evolution of the productivities of activities in the economy.

Interestingly, we also note that inequality in the productivity distribution increases significantly over time. This follows because, by the result of Proposition 4.4, petty corruption is relatively more attractive than high-level corruption under the output-maximizing power distribution. Hence, the productivities of less productive activities grow more slowly than those of more productive activities so that the productivity distribution becomes skewed towards the more productive activities. By the intuition underlying the result of Proposition 4.3(c), this is accompanied by a reduction in societal corruption.

Figure 7 displays the evolution of the bias of the optimal power distribution in each period. We note that it initially varies slowly over time, then increases, and finally approaches a steady state level. For this class of societies, the bias of the optimal power distribution is negative. Consistent with the results of Proposition 4.4, it lies in the interval $[-1,1]$. In the "optimal" society, therefore, power declines with productivity and petty corruption is relatively more prevalent than high-level corruption.

VII. Conclusions

Using a multi-period model of corruption in a heterogeneous society, we examine the effect on societal corruption and output of the interplay among the societal compensation structure, the distribution of power, and the distribution of productivities of activities in the economy. We show that the distribution of power in the society significantly affects the level of societal corruption, the skew or curvature of the output-maximizing *societal compensation structure* in any period, as well as the relation between societal corruption and *inequality*. In any period, societal corruption varies in a U-shaped manner with the *bias* of the power distribution. Depending on the distribution of agents across activities, power could either increase or decrease with productivity in the "optimal" society. Petty corruption is relatively predominant in such a society and compensation increases with, but is less than proportional to, productivity. Our results have the positive implication that societal corruption varies in a U-shaped manner with the relative level of public sector wages. We find significant empirical support for this prediction. Our analysis also has the policy implications that high level corruption should be targeted by legal systems in developed economies, while petty corruption should be targeted in developing economies and that the public sectors in highly productive, advanced economies should have relatively greater power.

The distribution of power significantly affects the evolutions of corruption, output, and inequality. Depending on the societal power distribution, the society can be characterized by endemically high corruption over time with declining output, intermediate and stable corruption levels and growth rates, declining corruption and rising growth rates, and non-monotonically varying corruption along with unstable growth.

Our study relates themes from different strands of the literature – one examining the relation between power and remuneration on corruption at the individual level; and the other investigating the relations among corruption, inequality, and growth at the societal level. Our results emphasize the importance of studying the relationships among corruption, compensation, power, and inequality in a unified setting in order to capture their interactive effects. Political and legal institutions, as determinants of the distribution of power, crucially affect the level of corruption in society, its evolution, and persistence. As factors such as the exposure to democracy, the legal system, and federalism are likely to significantly influence the distribution of power, our theory sheds some light on the channels through which these factors affect corruption.

Although we focus on modeling corruption at the societal level in this paper, the framework that we develop and analyze can also be applied to the study of corruption in any large organization or firm. In this context, the *organizational structure* reflects the distribution of power within the firm. Our analysis and results applied to this setting could shed light on the relationships between a firm's organizational design and its compensation structure (that is, the remunerations of its employees), as well as on the optimal (output-maximizing) choices of these variables by the firm's diversified, risk-neutral owners (residual claimants).

i # Appendix

Proof of Proposition 3.1

By (3.1)-(3.3), for a given set of corruption levels $(a^t_{-(k,l)})$ of other agents, the optimal corruption choice $a^t_{k,l}*$ of individual l in activity k is given by

(A1)

$$a^t_{k,l}* = 1 \wedge \arg\max_V \; E\left[-\left(\frac{\left(w^t_k + 1_{\{S_{k,l}=0\}} V p^t_k - 1_{\{S_{k,l}=1\}} \frac{1}{2} k V^2 w^t_k\right)}{\sum_{i=1}^{n}\sum_{j=1}^{g^t_i} 1_{(i,j)\neq(k,l)} \left(w^t_i + 1_{\{S_{i,j}=0\}} a^t_{i,j} p^t_i - 1_{\{S_{i,j}=1\}} \frac{1}{2} k (a^t_{i,j})^2 w^t_i\right)}\right)\left(\sum_{i=1}^{n}\sum_{j=1}^{g^t_i} 1_{(i,j)\neq(k,l)} [(1-a^t_{i,j}) v^t_i]\right)\right]$$

In (A1), we note that the only term inside the expectation that depends on V is the term $\left(w^t_k + 1_{\{S_{k,l}=0\}} V p^t_k - 1_{\{S_{k,l}=1\}} \frac{1}{2} k V^2 w^t_k\right)$. Since $\{S_{i,j}\}$ are independent binary random variables, we see from (A1) that individual (k,l)'s optimal corruption choice is

(A2) $$a^t_{k,l}* = 1 \wedge \arg\max_V \left(q_k V p^t_k - (1-q_k) \frac{k V^2 w^t_k}{2} \right) = \min\left(\frac{q_k}{1-q_k}\frac{p^t_k}{k w^t_k}, 1\right)$$

(A2) characterizes each individual's *dominant pure strategy* in equilibrium. Q.E.D.

Proof of Proposition 4.1

a) We begin by recalling that, from (2.8) and (2.9), societal corruption minimization and output maximization are equivalent objectives. By (2.8) and (3.5), for given productivity and power distributions, the societal corruption minimization problem over the class of societies with no maximally corrupt individuals can be expressed as follows:

(A3) $$\min_{\{w^t_i\}} \sum_{j=1}^{n} g^t_j \frac{p^t_j v^{t\,\prime}_j}{w^t_j} \quad \text{with} \quad \sum_{j=1}^{n} g^t_j w^t_j = 1$$

We note that the societal corruption level is a convex function of the vector of honest shares $(w^t_1, \ldots, w^t_n)$. Hence, the necessary and sufficient conditions for an *interior* minimum are

(A4) $$\frac{p^t_j v^{t\,\prime}_j}{{w^t_j}^2} = \text{constant} \quad \text{for } j = 1, \ldots, n$$

It follows from (A4) that

(A5) $$w^t_j = l^t \sqrt{v^{t\,\prime}_j p^t_j} \quad j = 1, \ldots, n$$

where the value of the proportionality constant l^t ensures that $\sum_{j=1}^{n} g_j^t w_j^t = 1$, that is,

(A6) $$\frac{1}{l^t} = \sum_{j=1}^{n} g_j^t \sqrt{v_j^t{}' p_j^t} < \sqrt{p_{\max}} \sum_{j=1}^{n} g_j^t \sqrt{v_j^t{}'}\,.$$

The inequalities above follow from the fact that $p_j^t \le p_{\max};\, j = 1,...,n$.

In order to show that the compensation structure (A5) minimizes societal corruption, we need to show that no individual is maximally corrupt under this compensation structure. By (3.4), (A5) and (A6), the individual corruption levels under the compensation structure (A5) are given by

(A7) $$a_i^t{}^* = \min(1, \sqrt{p_i^t} \sum_{j=1}^{n} g_j^t \sqrt{\left(\frac{v_j^t{}'}{v_i^t{}'}\right)} \sqrt{p_j^t}) < \min(1, p_{\max} \sum_{j=1}^{n} g_j^t \sqrt{\left(\frac{v_j^t{}'}{v_i^t{}'}\right)}) < p_{\max} \sum_{j=1}^{n} g_j^t \sqrt{\left(\frac{v_{\max}^t}{v_{\min}^t}\right)} = Np_{\max} \sqrt{\left(\frac{v_{\max}^t}{v_{\min}^t}\right)}$$

By (A7) and assumption (4.1), we see that $a_i < 1 \ \forall i$. Hence, no individual is maximally corrupt and the compensation structure (A5) indeed minimizes societal corruption. The individual corruption levels are given by (4.3). By (2.8), the corresponding societal corruption level is given by (4.4).

<u>Proof of Proposition 4.3</u>

a) If $m = 1$ then it follows from (4.11) that the minimum attainable corruption level is given by

(A8) $$h_g^t{}^* = N\overline{p}^t \left(\sum_{i=1}^{n} g_i^t (v_i^t{}') \right)^2$$

Since $\sum_{i=1}^{N} g_i^t v_i^t{}' = 1$ by definition, it follows that the minimum (maximum) attainable societal corruption (output) level does not depend on the productivity distribution and is, therefore, unaffected by inequality.

b) If $m > 1$, it follows from (4.11) that the minimum attainable societal corruption level for a productivity distribution g is given by

(A9) $$h_g^t{}^* = N^m \overline{p}^t \left(\sum_{i=1}^{n} g_i^t (v_i^t{}')^{\frac{m+1}{2}} \right)^2$$

Since $m > 1$, $v^{(1+m)/2}$ is convex in v . It follows from the well-known property of second order stochastic dominance (see Huang and Litzenberger 1988) that

$$g \succ h \Rightarrow \sum_{i=1}^{n} g_i^t (v_i^t{}')^{\frac{m+1}{2}} > \sum_{i=1}^{n} h_i^t (v_i^t{}')^{\frac{m+1}{2}} \Rightarrow h_g^t{}^* > h_h^t{}^*$$

c) If $-1 < m < 1$, then $v^{(1+m)/2}$ is concave in v . It then follows as a property of second order stochastic dominance (see Huang and Litzenberger 1988) and (A9) that

$$g \succ h \Rightarrow \sum_{i=1}^{n} g_i^t (v_i^t{}')^{\frac{m+1}{2}} < \sum_{i=1}^{n} h_i^t (v_i^t{}')^{\frac{m+1}{2}} \Rightarrow h_g^t{}^* < h_h^t{}^*$$

d) If $m < -1$, then $v^{(1+m)/2}$ is again convex in v so that $g \succ h \Rightarrow h_g^t{}^* > h_h^t{}^*$ Q.E.D.

Proof of Lemma 4.1

We note that $\frac{d^2 w^t(y)}{dy^2} = \frac{1}{\sqrt{N}} \sum_{i=1}^{n} g_i^t \left(N v_i^t{}'\right)^y (\log(N v_i^t{}'))^2 > 0$ so that w^t is a strictly convex function. Next,

$$w^t(0) = \frac{1}{\sqrt{N}} \sum_{i=1}^{n} g_i^t = \sqrt{N} = \frac{1}{\sqrt{N}} \sum_{i=1}^{n} g_i^t \left(N v_i^t{}'\right) = w^t(1)$$

The second equality above follows from the fact that $\sum_{i=1}^{n} g_i^t = N$ and the third equality follows from the fact that $\sum_{i=1}^{n} g_i^t v_i^t{}' = \sum_{i=1}^{n} g_i^t [\frac{v_i^t}{\sum_{j=1}^{N} g_j v_j^t}] = 1$. Since w^t is strictly convex and non-constant, it attains a unique minimum at $y^t{}^* \in (0,1)$. Q.E.D.

Proof of Proposition 4.4

a) By (4.11), the output-maximizing bias of the societal power distribution solves:

(A10) $$m^t{}^* = \arg\min_{m \in [m_{\min}^t, m_{\max}^t]} \left(\frac{1}{\sqrt{N}} \sum_{i=1}^{n} g_i^t (N v_i^t{}')^{(1+m)/2} \right)^2 = \arg\min_{m \in [m_{\min}, m_{\max}]} B(m)$$

By the result and proof of Lemma 4.1, $B(.)$ is strictly convex. It is strictly decreasing for $m \in [m_{\min}^t, 2y^t{}^* - 1]$ and strictly increasing for $m \in [2y^t{}^* - 1, m_{\max}^t]$ where $y^t{}^* \in (0,1)$ is defined in Lemma 4.1. Hence, by (4.11), $h^t{}^*(m)$ is strictly convex and varies in a U-shaped manner for $m \in [m_{\min}^t . m_{\max}^t]$.

b) By the result of part a), it follows that, if $2y^t{}^* - 1 \le m_{\max}^t$, then $h^t{}^*(m)$ attains a minimum at $\max(2y^t{}^* - 1, m_{\min}^t)$. On the other hand, if $2y^t{}^* - 1 > m_{\max}^t$, then $h^t{}^*(m)$ is decreasing over the feasible range $[m_{\min}^t, m_{\max}^t]$ and attains its minimum at $m_{\max}^t$..

c) Since $y^t{}^* \in (0,1)$ by Lemma 4.1, we see that $m^t{}^* \in (-1,1)$ and $(1 + m^t{}^*)/2 \in (0,1)$. It follows from (4.9) that the optimal societal compensation structure is increasing and strictly concave.

d) From the above, we note that, if $B'(0) < 0$, then $m^t{}^* \in (0,1)$, whereas if $B'(0) > 0$, then $m^t{}^* \in (-1,0)$. By (A10), we see that $B'(0)$ is negative (positive) if and only if the expression on the left hand side of (4.14) is negative (positive). Q.E.D.

References

Acemoglu, D. and T. Verdier, 1998. Property rights, corruption and the allocation of talent: A general equilibrium approach, *Economic Journal* 108, 1381-1402.

Acemoglu, D. and T. Verdier, 2000. The Choice between Market Failures and Corruption, *American Economic Review* 90, 194-211.

Ades, A. and R. Di Tella, 1999, Rents, Competition and Corruption, *American Economic Review*, 89, 982-992.

Ahlin, C., 2001. Corruption: Political determinants and Macroeconomic effects, *Working Paper.*

Aidt, T., 2003, Economic Analysis of Corruption: A Survey, *Economic Journal*, 113, F632-F652.

Andvig, J. and Moene, K.O., 1990, "How Corruption may Corrupt", *Journal of Economic Behavior and Organization*, 13, 63-76.

Angeletos, G.M. and T. Kollintzas., 2000, "Rent Seeking/Corruption and Growth: A Simple Model", *Center for Economic Policy Research* Discussion Paper No. 2464.

Bardhan, Pranab, Corruption and Development: A Review of Issues, 1997, *Journal of Economic Literature* 35, 1320-1346.

Barro, Robert and Xavier Sala-i-Martin, 2004, *Economic Growth*, Second Edition, Prentice-Hall.

Basu K., S. Bhattacharya and A. Mishra, 1992. Notes on bribery and the control of corruption, *Journal Of Public Economics* 48, 349-359.

Becker, G., and Stigler, G., 1974, "Law Enforcement, Malfeasance, and Compensation of Enforcers", *Journal of Legal Studies*, 3, pp. 1-19.

Besley, Timothy and John McLaren, 1993. Taxes and bribery: The role of wage incentives, *The Economic Journal* 103, 119-141.

Cadot, Olivier, 1987. Corruption as a Gamble, *Journal of Public Economics*, vol. 33, no.2, pp. 223-243.

Carrillo, Juan D., 2000. Graft, Bribes, and the Practice of Corruption, *Journal of Economics and Management Strategy*, vol. 9, 257-286.

Di Tella, Rafael and Ernesto Schargrodsky, 2003. The Role of Wages and Auditing During a Crackdown on Corruption in the City of Buenos Aires, *Journal of Law and Economics*, vol. 46, 269-292.

Ehrlich, Isaac And Francis T. Lui, 1999. Bureaucratic Corruption and Endogenous Economic Growth, *Journal of Political Economy* 107, S270-S292.

Gupta, S., H. Davoodi and A. Rosa, 1998. Does Corruption Affect Income Inequality and Poverty? *IMF Working Paper*, WP/98/76.

Hauk, Esther and Maria Saez-Marti, 2002. On the Cultural Transmission of Corruption, *Journal of Economic Theory*, 107, 311-335.

Heston, Alan, Robert Summers and Bettina Aten, 2002. Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP).

Huang, Chi-Fu and Robert Litzenberger, 1988. *Foundations for Financial Economics*, Prentice Hall, N.J.

Leite, C. and J. Weidmann, 1999. Does Mother Nature Corrupt? Natural Resources, Corruption, and Economic Growth, *IMF Working Paper*, WP/99/84.

Li, H., L.C. Xu and H-F Zou, 2000. Corruption, income distribution and growth, *Economics and Politics*, 12, 155-182.

Lui, Francis T., 1985. An Equilibrium Queuing Model of Bribery, *Journal of Political Economy*, 93, 760-781.

Mauro, Paolo, 1995. Corruption and Growth, *Quarterly Journal of Economics*, vol. 90, pp. 681-712.

Mookherjee, D. and I.P.L.Png, 1995. Corruptible law enforcers: How should they be compensated? *Economic Journal*, 105, 145-169.

Murphy, K.M., A. Shleifer and R. Vishny, 1991. The Allocation of Talent: Implications for Growth, *Quarterly Journal of Economics*, 86, 503-530.

Murphy, K.M., A. Shleifer and R. Vishny, 1993. Why is Rent-Seeking so costly to Growth? *American Economic Review Papers and Proceedings* 83, 409-413.

Myerson, R., 1992, Game Theory: Analysis of Conflict, *Dover Publications.*

Shi, S. and T. Temzelides, 2004, A Model of Bureaucracy and Corruption. *International Economic Review* 45, 873-908.

Tanzi, Vito and Hamid Davoodi, 1997. Corruption, Public Investment and Growth, *IMF Working Paper*.

Tanzi, Vito, 1998. Corruption Around the World: Causes, Consequences, Scope, and Cures, IMF Staff Papers.

Treisman, Daniel, 2000. The Causes of Corruption: A Cross-National Study, *Journal of Public Economics*, 76, 399-457.

Van Rijckeghem, C and B. Weder, 2001. Bureaucratic Corruption and the Rate of Temptation: Do Wages in the Civil Service Affect Corruption, and By How Much? *Journal of Development Economics,* 65 307-331.

Figure 1: Variation of Corruption with Honest Income Inequality for Various Power Distributions

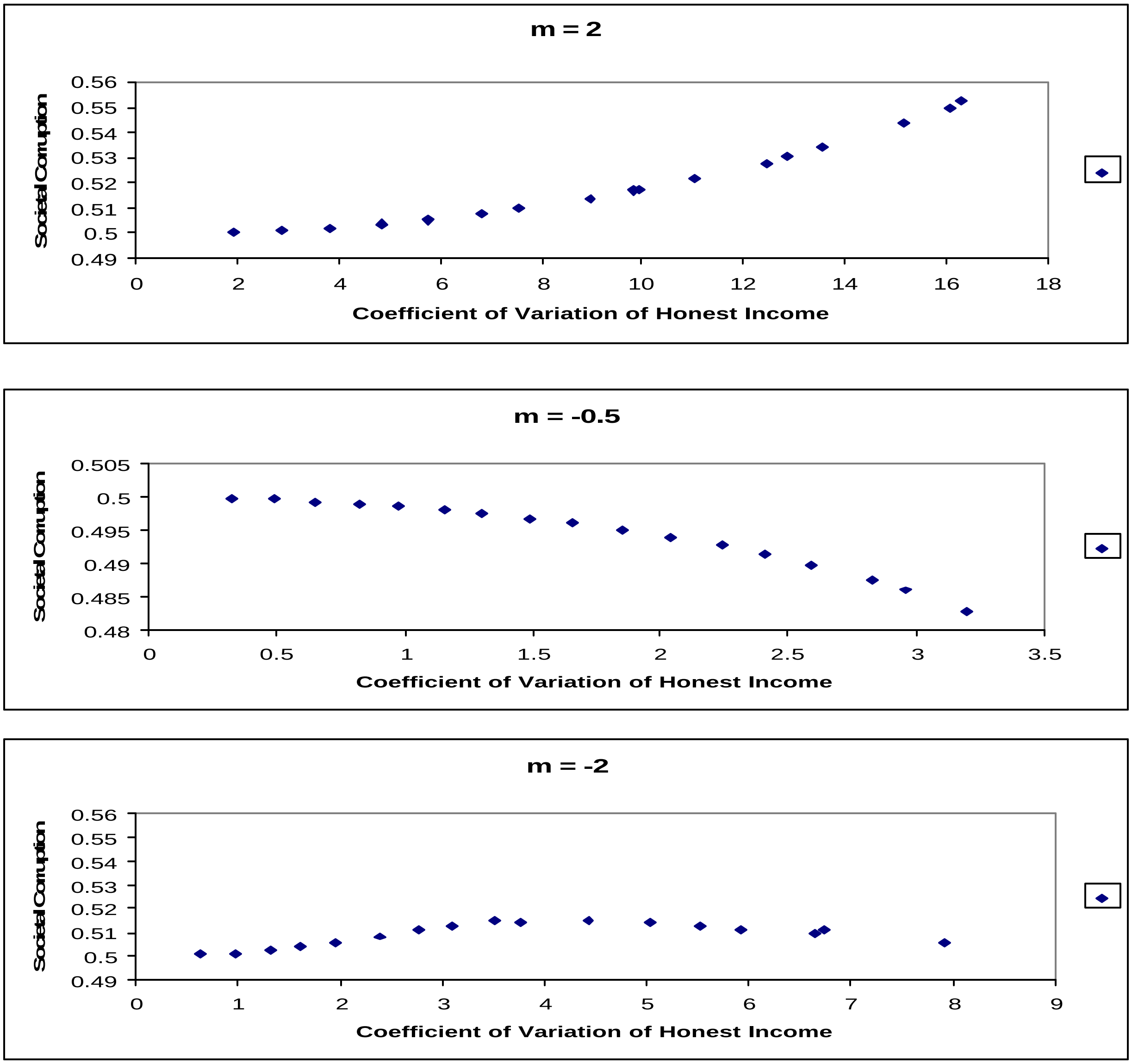


Table 1: Average Labor Productivities in the Private and Public Sectors

The table presents the average labor productivities per person over industries in the private sector and the average labor productivities per person in public administration and defense for 26 OECD countries using data obtained from the "Groningen Growth and Development Centre, 60-Industry Database, February 2005, **http://www.ggdc.net**". Except otherwise indicated, the data are averaged over the period 1979-2002 for each country and are in chained 1995 local currency units.

Country	Private Sector	Public Administration and Defense	% Difference
Australia	75,454	52,509	30.41%
Austria	65,181	42,892	34.20%
Belgium	63,479	39,162	38.31%
Canada	89,912	81,141	9.76%
Czech Republic (1993-2003)	397,541	264,285	33.52%
Denmark	469,324	454,632	3.13%
Finland	52,439	43,021	17.96%
France	65,643	50,125	23.64%
Germany	66,937	48,214	27.97%
Greece	136,843	23,669	82.70%
Hungary (1993-2003)	2,878,224	1,708,709	40.63%
Ireland	51,634	29,707	42.47%
Italy	72,732	29,987	58.77%
Japan	10,786,000*	9,345,000*	13.36%
Korea**	32,321,000**	25,244,000**	21.90%
Luxembourg	78,455	62,586	20.23%
Netherlands	71,601	46,762	34.69%
Norway	615,190	278,318	54.76%
Poland (1993-2003)	32,224	48,689	-51.10%
Portugal	28,236	18,082	35.96%
Slovakia (1993-2003)	494,212	308,943	37.49%
Spain	51,420	22,333	56.57%
Sweden	493,691	303,180	38.59%
Taiwan	1,288,006	1,209,944	6.06%
United Kingdom	37,420	27,559	26.35%
United States	75,535	60,680	19.67%

* in 1000s of chained 1995 yen
** in 1000s of chained 1995 won

Table 2: Descriptive Statistics

The table presents descriptive statistics for all variables used in our empirical analysis. *British Colony* is a dummy variable taking the value one if the country was ever a British colony in the past, *Democracy* is a dummy variable taking the value one if the country was a continuous democracy from 1960-2000, *Federal* is a dummy variable that takes the value one if the country has a federal government structure, and *Common Law* is a dummy variable that takes the value one if the country has a common law system. *Imports* is the country's imports as a percentage of its GDP in the year 1999. *Relative Government wage* is the country's average government wage as a proportion of its per capital GDP over the years 1996-2000. *Protestant* is the percentage of the country's population that was Protestant in the year 1980. *Fuels, Metals and Minerals* is the percentage of a country's merchandise exports comprising of fuels, metals, and minerals in 1993. *Prior Average Per Capita GDP* is the average per capital GDP over the period 1980-1990.

	N	Mean	Median	Maximum	Minimum	1st quartile	3rd quartile	Std. Dev.	Skewness	Kurtosis
Transparency International Corruption Score 2004	146	5.99	6.80	8.50	0.30	5.00	7.70	2.19	-1.15	3.18
British Colony	165	0.27	0.00	1.00	0.00	0.00	1.00	0.44	1.06	2.11
Democracy	165	0.12	0.00	1.00	0.00	0.00	0.00	0.33	2.32	6.39
Federal	165	0.13	0.00	1.00	0.00	0.00	0.00	0.34	2.16	5.65
Imports	164	43.72	39.83	143.87	8.53	27.99	54.33	22.66	1.41	5.92
Prior Relative Government Wage	154	2.29	1.80	6.80	0.00	1.10	3.38	1.60	0.82	2.75
Prior Relative Government Wage^2	154	7.77	3.24	46.24	0.00	1.21	11.39	9.79	1.69	5.42
Protestant	99	14.68	2.70	97.80	0.00	0.60	19.55	23.29	2.13	7.10
Common Law	99	0.31	0.00	1.00	0.00	0.00	1.00	0.47	0.81	1.65
Fuels, Metals and Minerals	85	15.45	5.00	96.00	0.00	1.00	16.00	22.93	2.03	6.54
Log Prior Average Per Capita GDP	131	3.58	3.57	4.38	2.69	3.27	3.94	0.42	-0.21	1.96

Table 3: Correlation Matrix of Independent Variables

The following table shows the correlations between the main independent variables in our analysis. *British Colony* is a dummy variable taking the value one if the country was ever a British colony in the past, *Democracy* is a dummy variable taking the value one if the country was a continuous democracy from 1960-2000, *Federal* is a dummy variable that takes the value one if the country has a federal government structure, and *Common Law* is a dummy variable that takes the value one if the country has a common law system. *Imports* is the country's imports as a percentage of its GDP in the year 1999. *Relative Government wage* is the country's average government wage as a proportion of its per capital GDP over the years 1996-2000. *Protestant* is the percentage of the country's population that was Protestant in the year 1980. *Fuels, Metals and Minerals* is the percentage of a country's merchandise exports comprising of fuels, metals, and minerals in 1993. *Prior Average Per Capita GDP* is the average per capital GDP over the period 1980-1990.

	British Colony	*Democracy*	*Federal*	*Imports*	*Prior Relative Government Wage*	*Prior Relative Government Wage^2*	*Protestant*	*Common Law*	*Fuels, Metals and Minerals*
Democracy	0.11								
Federal	0.09	0.35							
Imports	0.20	-0.13	-0.18						
Prior Relative Government Wage	0.23	-0.17	-0.02	0.00					
Prior Relative Government Wage^2	0.21	-0.18	-0.04	-0.01	0.96				
Protestant	0.04	0.39	0.00	0.00	-0.05	-0.04			
Common Law	0.79	0.09	0.13	0.12	0.29	0.30	0.11		
Fuels, Metals and Minerals	0.00	-0.15	0.09	-0.25	0.19	0.17	-0.08	0.01	
Log Prior Average Per Capita GDP	-0.09	0.45	0.22	0.12	-0.45	-0.46	0.31	-0.19	-0.20

Table 4: Relationship between Societal Corruption and the Average Relative Government Wage

This table shows the results of OLS regressions of corruption on the average relative government wage controlling for other important determinants of corruption. The dependent variable is a country's *Corruption Score* for the year 2004 published by Transparency International adjusted so that its value ranges from 0 (least corrupt) to 10 (most corrupt). *British Colony*, *Democracy*, *Federal*, and *Common Law* are dummy variables taking the value one if the country was ever a British colony in the past, was a continuous democracy from 1960-2000, has a federal government structure, and has a common law system, respectively. *Imports* measures the country's imports as a percentage of its GDP in the year 1999. *Prior Relative Government Wage* is the country's average government wage as a proportion of its per capital GDP over the years 1996-2000. *Protestant* is the percentage of the country's population that was Protestant in the year 1980. *Fuels, Metals and Minerals* is the percentage of a country's merchandise exports comprising of fuels, metals, and minerals in 1993. *Prior Average Per Capita GDP* is the logarithm of the average per-capita GDP of the country over the period 1980-1990. P-values are reported in parentheses below the coefficient estimates.

Independent Variables	Model 1	Model 1a	Model 2	Model 2a	Model 3	Model 3a
British Colony	-0.39 (0.21)	-0.46 (0.14)	-0.72 (0.21)	-0.69 (0.29)	-0.37 (0.60)	-0.77 (0.27)
Democracy	-4.16*** (0.00)	-2.88*** (0.00)	-3.11*** (0.00)	-1.76*** (0.00)	-2.93*** (0.00)	-1.67*** (0.00)
Federal	0.09 (0.83)	0.40 (0.30)	-0.02 (0.96)	0.30 (0.43)	0.02 (0.96)	0.24 (0.55)
Imports	-0.02*** (0.00)	-0.02*** (0.01)	-0.03*** (0.00)	-0.01** (0.02)	-0.03*** (0.00)	-0.02** (0.04)
Prior Relative Government Wage	-0.58* (0.06)	-0.78*** (0.01)	-0.79** (0.03)	-0.78** (0.02)	-0.98** (0.02)	-0.98** (0.01)
(Prior Relative Government Wage)^2	0.12*** (0.01)	0.12** (0.02)	0.17*** (0.01)	0.13** (0.02)	0.19*** (0.01)	0.15** (0.02)
Protestant			-0.03*** (0.00)	-0.03*** (0.00)	-0.04*** (0.00)	-0.03*** (0.00)
Common Law			0.63 (0.27)	0.05 (0.94)	0.46 (0.5)	0.25 (0.73)
Fuels, Metals and Minerals					0.01 (0.49)	0.01 (0.27)
Log Prior Average Per Capita GDP		-3.01*** (0.00)		-3.17*** (0.00)		-3.14*** (0.00)
Intercept	7.95*** (0.00)	18.70*** (0.00)	8.23*** (0.00)	19.16*** (0.00)	8.35*** (0.00)	19.18*** (0.00)
R^2	0.5	0.67	0.62	0.77	0.64	0.77
Number of Observations	146	121	95	87	81	77
Durbin-Watson	1.82	2.00	2.18	1.78	2.47	1.84

*Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level

Figure 2: Variation of Corruption with Relative Government Wage

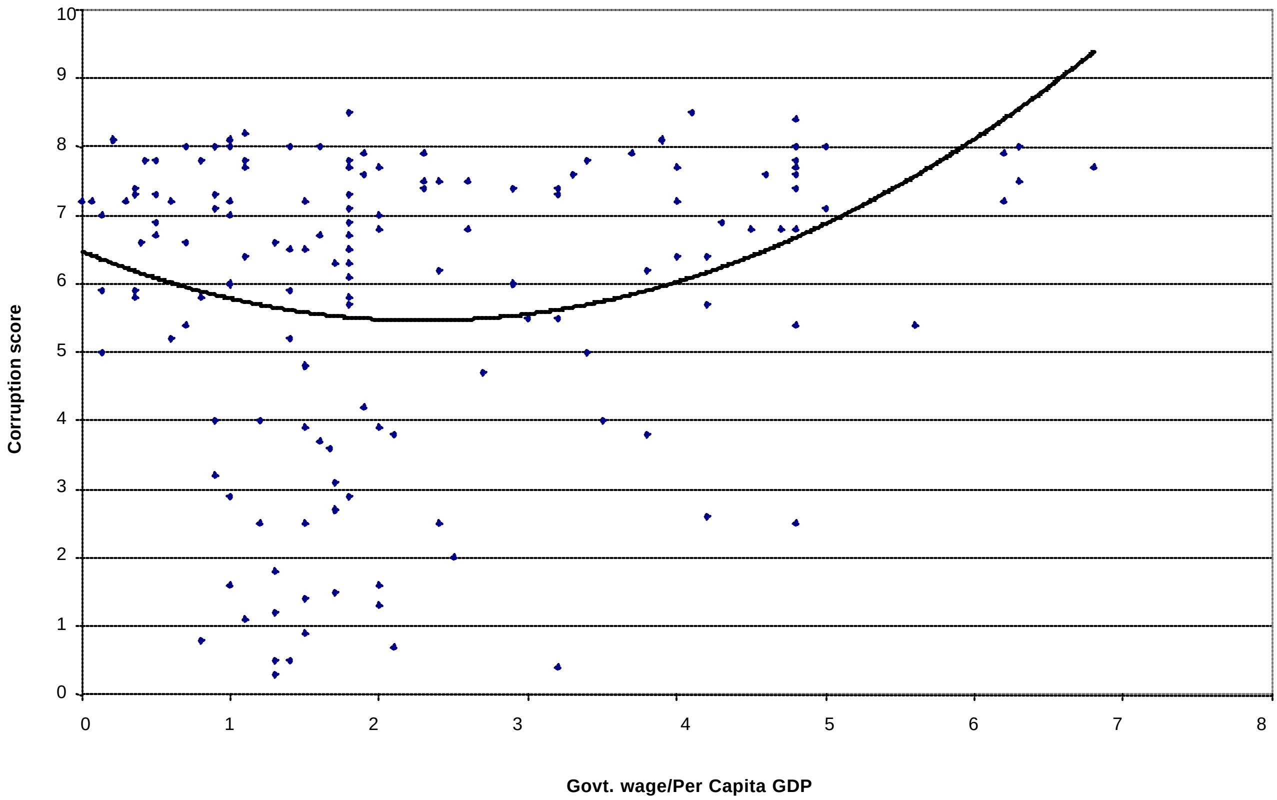


Figure 3: Variation of Societal Corruption over Time

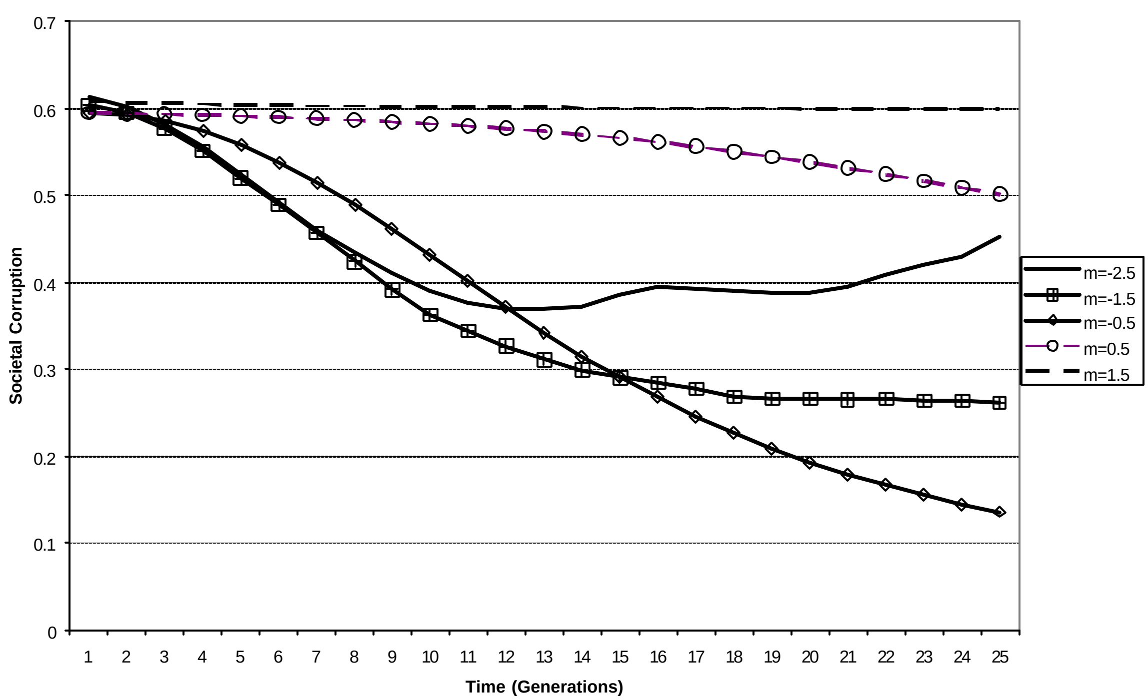


Figure 4: Variation of Log Per Capita Output over Time

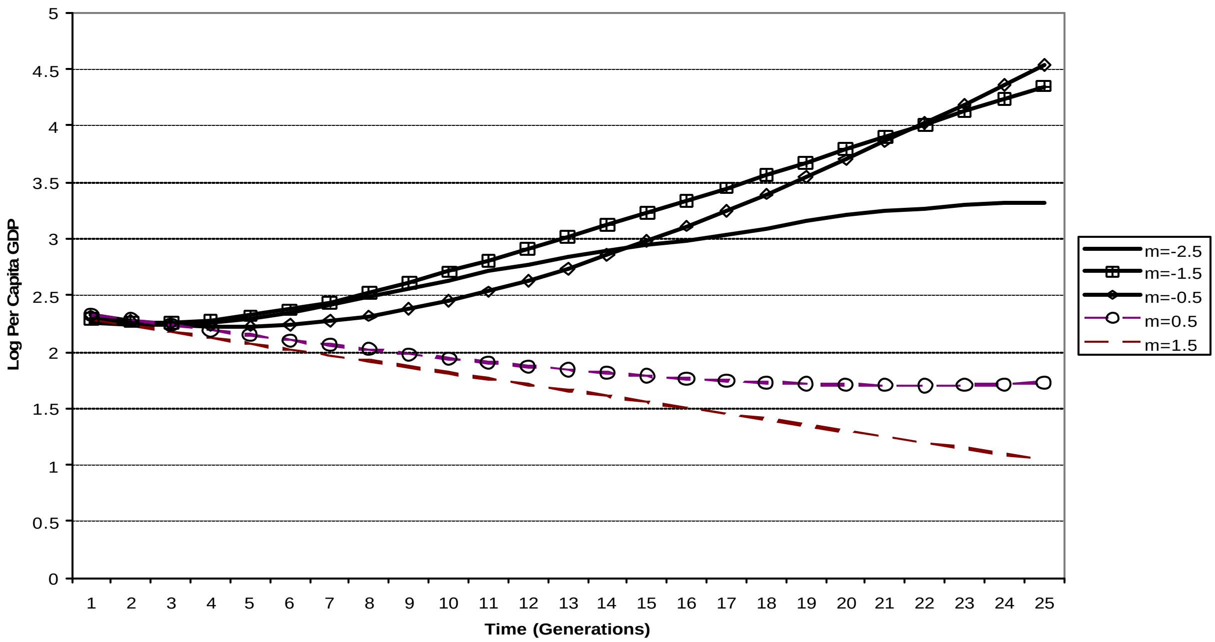
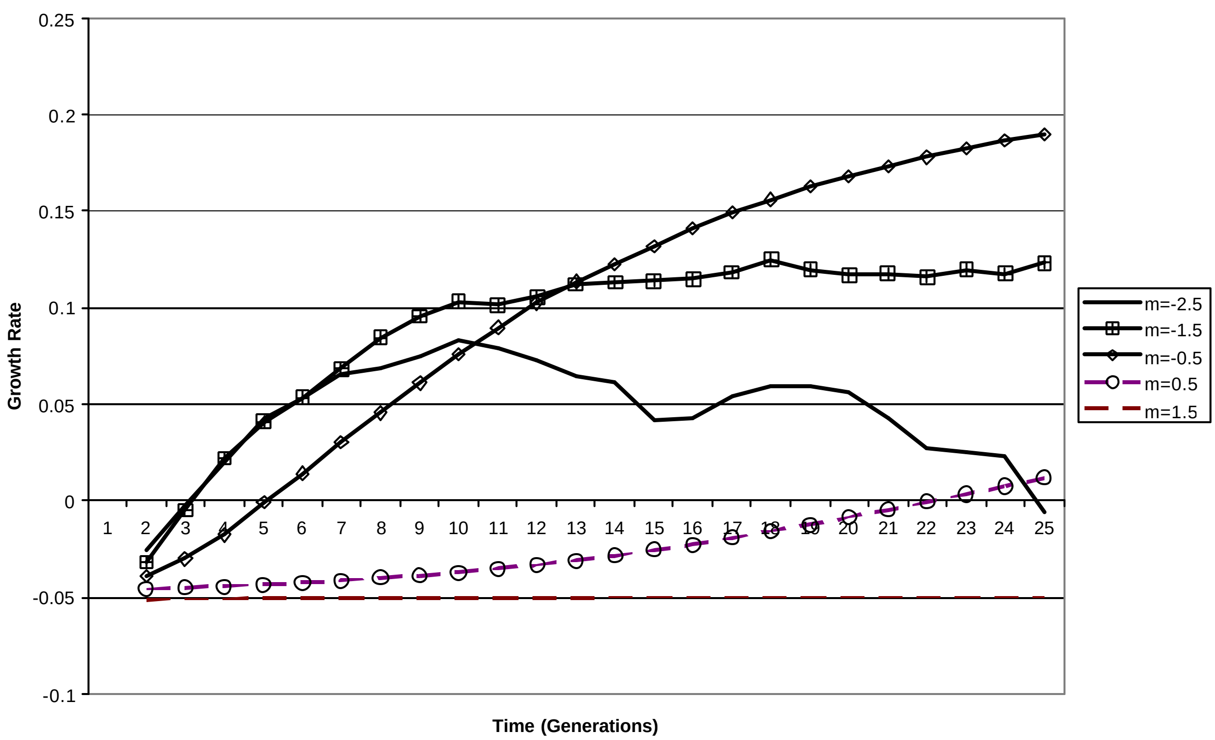


Figure 5: Variation of Growth Rate over Time



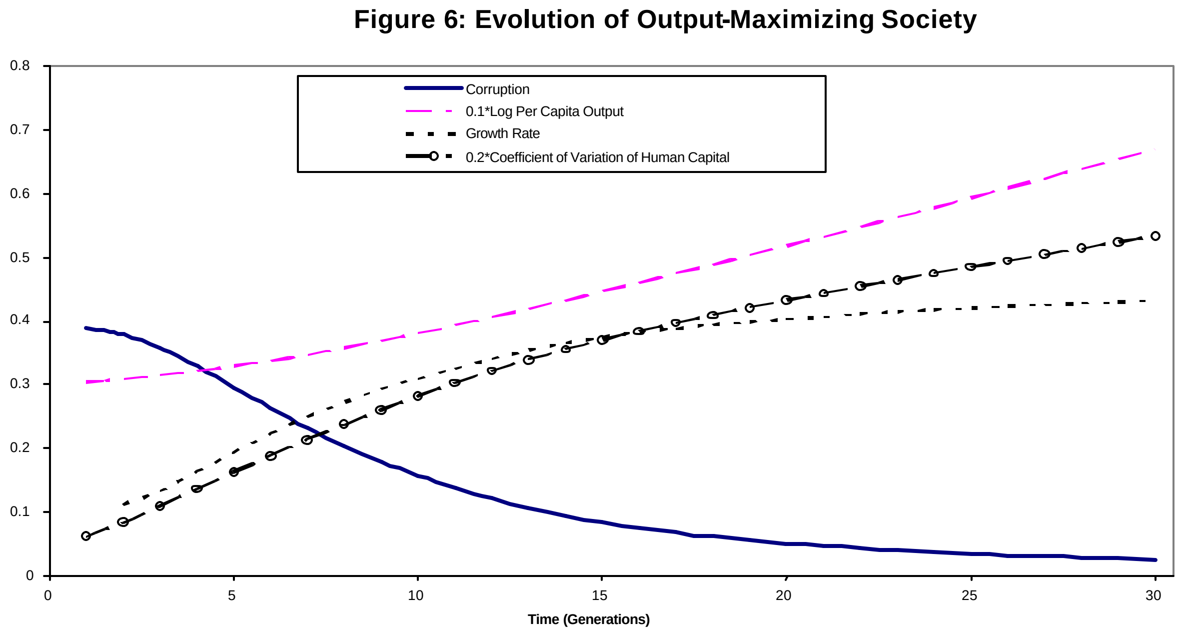
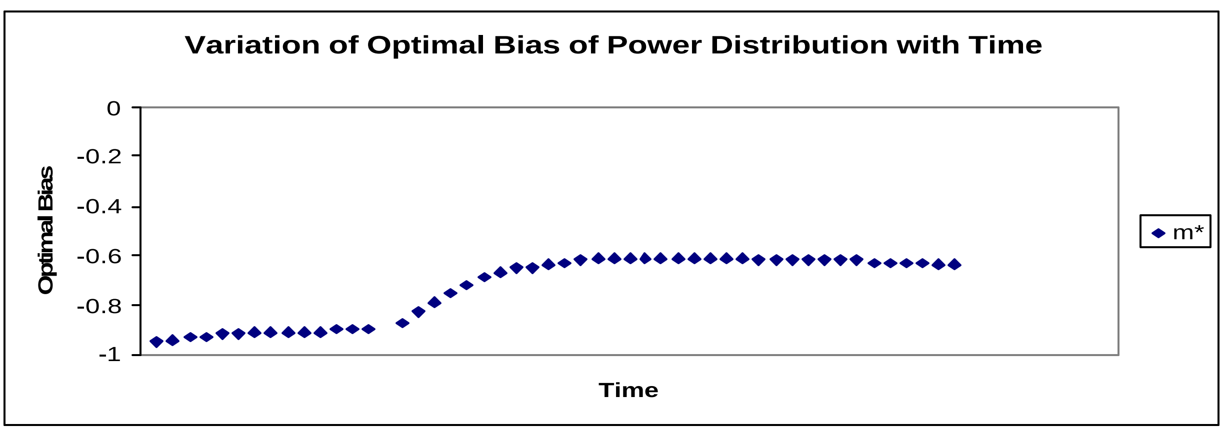


Figure 6: Evolution of Output-Maximizing Society
Corruption
0.1*Log Per Capita Output
Growth Rate
0.2*Coefficient of Variation of Human Capital
Time (Generations)

Figure 7:



Variation of Optimal Bias of Power Distribution with Time
Optimal Bias
m*
Time