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Does Mother Nature Corrupt? Natural Resources, Corruption, and Economic Growth

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Abstract

This paper argues that natural resource abundance creates opportunities for rent-seeking behavior and is an important factor in determining a country's level of corruption. In a simple growth model, we illustrate the interrelationships between natural resources, corruption, and economic growth, and discuss potential anti-corruption policies. We show that the extent of corruption depends on natural resource abundance, government policies, and the concentration of bureaucratic power. Furthermore, the growth effects of natural resource discoveries and anticorruption policies crucially depend on the economy's state of development. We empirically corroborate the model's implications in a cross-country framework with both corruption and growth endogenized.

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I. Introduction

The intensification of the public debate on governance, together with the increased emphasis on governance issues in policy deliberations, have served to direct a considerable research effort at the examination of the effects of institutional quality on economic performance. Many recent studies, for example North (1990) and Schleifer and Vishny (1993), have argued that malfunctioning government institutions severely harm economic performance through a reduction in both incentives and opportunities to invest and innovate. Among the different aspects of governance, corruption has received particular attention by both policy makers and researchers as the recent availability of corruption measures has helped to quantify its extent and allowed international comparisons. In a pioneering study, Mauro (1995) emphasizes that corruption may constitute a significant obstacle to investment. Nevertheless, different economic aspects of the corruption issue remain unexamined. In particular, the determinants of corruption and its effect on growth through channels other than investment have so far received scant attention.

Issues of corruption may be particularly relevant in the context of natural resource abundance, as natural resource exploration is an extremely high rent activity likely to foster rent-seeking behavior. The associated increase in rent-seeking opportunities may help to explain Sachs and Warner (1995a)'s paradoxical finding of a negative relationship between natural resource abundance and long-run economic growth. While a casual glance through history may suffice to turn up enough anecdotal examples to informally support Sachs and Warner (1995a), and while bad management of windfall gains bears clear dangers for economic prosperity, theoretical explanations are anything but conclusive. The Dutch disease mechanism does suggest that a resource boom tends to reduce the level of competitiveness of the non-resource sector, but economic policy makers should be able to attenuate this tendency. Furthermore, standard economic theory makes a case, only for a temporary negative growth effect; in the long run, the wealth effects associated with natural resources should lead to increased investment and higher economic growth. The present paper argues that part of the apparent negative correlation between natural resource abundance and growth may be due to an endogeneity issue: corruption is determined within the economic system, and it should therefore, be seen as a consequence of the interaction of economic interests and the use of policy instruments.

Thus, the aim of this paper is twofold. First, we investigate the determinants of corruption with a special emphasis on the role of natural resource abundance. Second, we examine the growth effects of corruption. Both issues are studied theoretically, within an open-economy, general equilibrium framework, as well as empirically within a simultaneous equation model with both economic growth and corruption endogenized. An additional question addressed herein centers on the possibility of attributing, to specific components of natural resources, a negative (or a positive) growth effect. Presumably, the amalgamation of the components of natural resources (fuel, ores and metals, agricultural products, and food) into one measure may obscure differences in their growth impact.

The outline of the remainder of the paper is as follows. The second section provides a brief literature review, situating the present paper in the context of the corruption and growth literature. Within a simple theoretical setting, Section III then discusses the effects of natural resource abundance on corruption, and illustrates how the latter may affect economic growth. In Section IV, we examine the empirically testable implications of our theoretical model, with a focus on evaluating the relevance of corruption as a transmission channel of natural resource effects on growth. Finally, Section V concludes and discusses the policy implications of our results.

II. Corruption and Natural Resources in the Growth Literature

Increasing recognition of the significant role of corruption in the process of economic development, fuelled in part by US political concerns about uneven rules on the legality of bribery,[2] has prompted a wide-ranging debate on the political-economy considerations of corruption, leading recently to significant anticorruption efforts on the part of some non-governmental and international organizations.[3] Within academic circles, the literature does include some studies on the benefits of corruption, but on the whole, theoretical work tends to support the notion that corruption impacts negatively on development. Recently, econometricians have weighed in with evidence suggesting that investment flows are one transmission channel for the deleterious effect of corruption on growth. However, quantitative evidence on the direct impact of corruption on growth, and on the determinants of the level of corruption, remains scant. In this section, we review the theoretical and empirical evidence on the role of corruption in economic growth,[4] discuss possible determinants of the level of corruption, and review the role of natural resources in economic growth.

A. The Role of Corruption in Economic Growth

The strand of the theoretical literature arguing that corruption can play a positive role in the development process relies on static efficiency arguments, essentially viewing bribing as a type of Coasean bargaining process. In this context, Leff (1964) and Huntington (1968) suggest that

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[2] US concerns center on the perceived disadvantage faced by US firms in the wake of The Foreign Corrupt Practices Act enacted by Congress in 1997. This act not only makes bribe payments ineligible for a tax deduction, but formally forbids US-based companies from engaging in the bribing of foreign officials. Only very recently have other OECD countries started to adopt similar legislation to govern the behavior of their own firms.

[3] See, for example, World Bank (1997), OECD (1997), and the directory of anti-corruption programs maintained on the Transparency International web page at http://www.tranparency.de/sigma/index.html.

[4] Our brief survey draws extensively on two excellent reviews of the corruption literature, Bardhan (1997) on analytical issues and Tanzi (1998) on policy issues.

corruption may allow entrepreneurs to work around extensive bureaucratic procedures, negating some of the deleterious effects of redtape; Liu (1985) uses an equilibrium queuing model to suggest that corruption allows the queue to be re-arranged in a way that brings about an efficient allocation of time, giving those for whom time is most valuable the opportunity to move to the front of the line; and Beck and Maher (1986) and Lien (1986) suggest that corruption may serve to ensure that projects are awarded to the most efficient firms, who stand to gain the most from payment of bribes.

On the first argument, Tanzi (1998) counters that bureaucratic procedures should be seen as the consequence, and not strictly as the initiators, of rent-seeking activities; and Myrdal (1968) suggests that, aside from the possible changes in the order in the queue, bribes may actually induce public servants to reduce the speed with which they process the queue. On the second and third arguments, Boycko, Shleifer and Vishny (1995) emphasize the added uncertainty resulting from the enforceability problems associated with corruption contracts. Notwithstanding the possible discipline imposed on the bribee by concerns about reputation, enforcement costs are liable to be larger than regular contracts, and moral hazard about the reliability of the transaction may be an important consideration. Liu (1985)'s conclusions may not be robust to such considerations. Furthermore, Baumol (1990), Murphy, Shleifer and Vishny (1991) and Liu (1996) contend that existing practices in more corrupt societies tend to encourage the most able to engage in rent seeking activities. It follows that the beneficiaries of corrupt practices are the most successful at rent-seeking, and not necessarily the most economically efficient. The reallocation of talent from productive to rent-seeking activities is posited to impact negatively on economic growth. The important corollary from each of the counter-arguments is that it may not be entirely appropriate to look at bribes as a simple Coasean bargaining process.

Efficiency assessments of corruption may also be significantly affected by two additional considerations: the nature of the corrupt system and the extent of corruption. Shleifer and Vishny (1993) note that, in a centralized system of corruption, the bribe-taker internalizes some of the distortionary effects, thereby reducing the inefficiency consequences of corruption. Rose Ackerman (1978) emphasizes that, once entrenched, bribery is difficult to limit to areas in which it might be economically desirable.

A second strand of the theoretical literature suggests that corruption reduces both investment and growth. On investment, Murphy, Shleifer and Vishny (1993) suggest that the prevalence of increasing returns to rent-seeking may crowd out productive investment; Romer (1994) suggests that corruption, by imposing a tax on ex-post profits may in general reduce the flow of new goods and technology, particularly if an initial fixed cost investment is required; and the argument in Boycko, Shleifer and Vishny (1995) mentioned above suggests that the added uncertainty may also serve to reduce investment flows.

On the direct effects of corruption on growth, Shleifer and Vishny (1993) note that the illegality associated with corruption necessitates efforts to avoid detection and punishment, causing "corruption to be more distortionary than taxation" (Shleifer and Vishny, 1993, p. 612). Indeed, the same study suggests that a detection-avoiding strategy may explain the preference of some officials towards the financing of projects on which the collection of bribes is easier, leading to the choice of infrastructure and defense projects over health and education expenditures, and reducing the quality of public services. Furthermore, Krueger (1993) suggests that "vicious circles" of rent-seeking and stifling regulations, for example in the context of an import substitution policy, might become entrenched, and even misdirected, and might only be resolved with the advent of an economic crisis. Finally, the labor misallocation emphasized by Baumol (1990), Murphy, Shleifer and Vishny (1991), and Liu (1996) would be expected to have a direct negative impact on economic growth.

Econometricians have recently weighed into the debate as Mauro (1995)'s pioneering study, together with the inception of the surveys now widely disseminated by Transparency International[5] (TI), brought to the attention of researchers the availability of corruption indices, and prompted a number of empirical investigations into the effects of corruption on various aspects of economic performance. Tanzi (1998) lists the significant econometric findings to date, namely the effects of corruption on (i) the level of investment, (ii) the productivity of public investment and the level of maintenance expenditures, (iii) the level of foreign direct investment, (iv) the level of education and health expenditures, and (v) the level of tax revenue. Given our interest in estimating a growth model, we restrict our review to empirical studies assessing either the role of investment as a transmission channel, namely Mauro (1995), Wei (1997) and Tanzi and Davoodi (1997), or the direct impact of corruption on growth, namely Poirson (1998) and Rama (1993).

Mauro (1995) uses subjective indices on institutional efficiency to analyze the relationship between institutional efficiency and economic growth, both directly and through the investment channel. The results provide some evidence that corruption affects investment although the probability value does fall to 12 percent when corruption[6] is instrumented using an index for ethnic diversity. On the direct relationship between corruption and growth, there is only "weak support" (Mauro, 1995, p. 704) with corruption becoming insignificant in the growth equation once investment is held constant.

The other two studies on the role of investment focus on particular components, Wei (1997) on foreign direct investment, and Tanzi and Davoodi (1997) on public investment. Wei (1997) uses individual survey responses to construct a measure of corruption-induced uncertainty. The results are consistent with an explanation that the uncertainty associated with corruption reduces foreign direct investment as suggested by Boycko, Shleifer and Vishny (1995). Tanzi and Davoodi (1997) provide cross-sectional evidence that higher corruption is associated with lower quality of public infrastructure, consistent with the conjecture by Shleifer and Vishny (1993) on the choice

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[5] See TI's home page at http://www.transparency.de/ or their joint initiative with Goettingen University, the Internet Center for Corruption Research, at http://www.gwdg.de/~uwvw/icr.htm.

[6] Replacing corruption with an index on bureaucratic efficiency yields a probability value of 8 percent.

of projects by corrupt officials. Neither Wei (1997) nor Tanzi and Davoodi (1997) estimate the subsequent impact on growth.

The only econometric evidence of a (statistically significant) direct effect of corruption on growth is provided by Poirson (1998) and Rama (1993). Poirson (1998) analyzes the effect of economic security on 53 countries over the period 1984-95. In the context of a growth equation typical of the recent empirical growth literature, this study includes measures on investment, openness and corruption as exogenous explanatory variables, and finds that corruption significantly reduces economic growth rates. Within a reduced form (AK) endogenous growth model, Rama (1993) endogenizes lobbying costs incurred by the firm. Using data for Uruguay over the period 1947-98, and regressing long-run growth rates on sectoral and aggregate investment rates, this study finds that lagged values of restrictive regulations decrease growth at the aggregate level.

B. The Determinants of Corruption

Corruption can take many forms, and it can even be embedded in cultural traditions, but its analysis generally focuses on the variant associated with government activity. Early studies followed Krueger (1974) in investigating the effects of regulations on foreign trade, and in pointing out that government restrictions on economic activity tend to generate both rents and rent-seeking behavior. Below, we briefly discuss some of the factors suggested as contributors to the incidence of corruption.

Viewing corruption as an illegal activity, we can follow Becker (1968)'s suggestion that the probability of committing a crime depends primarily on the penalty imposed and on the probability of being caught. In addition, the deterrent value of the penalties depends crucially on the ability and willingness of the authorities to enforce the relevant regulations, as well as on the level of acceptance, by the citizenry, of the judgements rendered by the country's institutions. Two corollaries are that political stability and transparency of rules are likely to be necessary conditions for an effective anti-corruption strategy. That is, countries beset by political instability are unlikely to generate the political muscle necessary to adequately empower judicial institutions, and situations of confusing rules and perplexing procedures are unlikely to generate the required widespread understanding and support.

The trade literature suggests that trade restrictions generate a significant amount of rents and rent-seeking activities, noted by Bhagwati (1982) to include not only attempts to evade tariffs but also efforts at *premium seeking* when agents compete for premium-fetching licenses, *revenue seeking* when agents try to appropriate a share of the revenue resulting from import restrictions, and *tariff seeking* when agents lobby for the imposition of protectionist tariffs. Krueger (1974) estimates that rents generated by government regulations in import licenses exceeded 5 percent of national income for India in 1964 and about 15 percent of GNP for Turkey in 1968, suggesting that rents accruing from the imposition of trade regulations are both theoretically and quantitatively significant. It follows that the degree of openness to foreign trade should be an important factor in determining the level of rent-seeking activities, or the extent of corruption.

The paucity of empirical work on the determinants of corruption is reflected in the existence of only two empirical studies, Van Rieckenghem and Weder (1997), and Rauch and Evans (1999). The first study, uses the idea of efficiency wages to argue that, under certain circumstances, higher wages in the public sector can deter corruption by increasing the potential loss in case of detection. Using data on some 25 developing countries, this study finds a significant impact of the public-private sector wage differential on the level of corruption.[7] In a similar vein, Rauch and Evans (1999), in a study covering 35 developing countries, present quantitative evidence suggesting that the extent of corruption is higher in countries in which civil service recruitment and promotion procedures rely less on merit-based considerations.

C. The Role of Natural Resources in Economic Growth

Similar to the case of corruption, the role of natural resources in economic development has been an area of ardent debate in economics. From earlier findings of a secularly declining price to later evidence on higher price volatility, policymakers have been encouraged not to rely extensively on resource-based growth, and theorists have debated widely on the optimal stance of public policy in the face of abundant natural resources. For purposes of our discussion, it is useful to distinguish between direct and indirect effects of natural resources. Direct effects have been labeled as the "Dutch disease" since the 1960s, when large discoveries of natural gas led to a recession in the Netherlands.[8] Indirect effects we ascribe to the impact of natural resources on rent-seeking activities and institution-building.

The direct effects of a resource boom (either in the form of new discoveries or price improvements) impact mainly on the non-resource traded goods sector. First, increased disposable income will be partly spent on non-traded goods, for example construction and services, causing prices in these sectors to rise. To restore equilibrium in the labor and nontraded goods market, the real exchange rate has to rise and real wages in the non-traded goods sector have to fall. This, in turn, reduces the competitiveness of the traded non-resource goods sector, partially crowding it out (*spending effect*). Second, factor remuneration will increase in the booming natural resource sector and lure workers and capital away from the other sectors (*resource pull effect*). The size of both effects is thus, to a large extent, determined by the sector's

[7] More specifically, Van Rieckenghem and Weder (1997) find that, in a cross-country regression, the differential between wages in the civil service and in manufacturing is a significant determinant of the corruption index assembled by the IRIS Center of the University of Maryland. The same independent variable, however, turns out to be insignificant in a panel setup.

[8] More recent examples of recessions induced by resource booms include the United Kingdom in the late 1970s, following the discovery and exploitation of the North Sea oil fields, and other oil exporting economies in the late 1970s and early 1980s, following the reversion of the price of oil to its longer-term trend (after the large increases of 1974/75 and 1978/79). In contrast, some countries, for example Malaysia and Botswana, have managed to harness the power of natural resources and maintain both economic stability and above-average growth rates.

labor-intensity and ownership: the higher the labor-intensity and the greater the level of domestic ownership, the more severe are the two effects.[9]

The contraction in the traded goods sector following an increase in natural resource revenues is what is frequently referred to as the Dutch disease. In reality, the adjustment process can be thought of as a rational response of the economy although overall welfare losses, through a reduction in long-term growth, can occur if linkages between the sectors, or more precisely the lack of positive externalities of the resource sector, are considered.[10]

Sachs and Warner (1995a), using data for some 70 countries, find a negative relationship between the ratio of natural resource exports and the rate of economic growth, even after controlling for variables such as initial per capita income, trade policy, and investment rates.[11] Quantitatively, the Sachs and Warner (1995a) estimates imply that an increase of one standard deviation in natural resource intensity (on average, 16 percent of GNP) leads to a reduction of about 1 percent per year in economic growth.

Indirect effects describe potential negative growth effects linked to the impact of resource abundance on the institutional quality of a country. The problem arises from the possible impact of windfall gains on rent-seeking behavior, as discussed in the previous section. Khan (1994), for example, attributes the pervasiveness of corruption in Nigeria to the oil boom. Lane and Tornell (1997) point out that windfall gains may cause a "feeding frenzy" in which competing groups fight for the natural resource rents thereby inefficiently exhausting the public good. This effect is exacerbated by the direct accrual to the government of a significant portion of the rents, possibly impeding the implementation of needed structural reforms and sometimes distracting public officials from investing in growth-supporting public goods. Sachs and Warner (1995b) empirically show that resource-abundant economies choose a more protective trade policy, liberalizing later than resource-poor economies.

III. A Simple Analytical Model

In this section, we model the influence of natural resources on, and the growth effects of, corruption within a neoclassical general equilibrium framework. In an open-economy infinite horizon growth model, we assume that investment projects need administrative approval which

[9] The second effect tends to be less relevant in the case of oil since the production process is not very labor-intensive and the domestic financing effects are generally limited.

[10] For an overview, see Sachs and Warner (1995a).

[11] As a robustness check, Sachs and Warner (1995a) re-estimate the main equations in Barro (1991), King and Levine (1993), Mankiw, Romer and Weil (1992) and DeLong and Summers (1991) while adding natural resource intensity and the openness variable. In all cases, the negative effect of natural resource intensity on long-run growth remains statistically significant.

is granted after the firm pays a bribe to the government employee. Hence, corruption acts like an investment tax borne by firms,[12] and ultimately by all shareholders, to the benefit of government employees who constitute a fixed share $0 < s < 1$ of the total population. $1-s$ will subsequently also be interpreted, and referred to, as an indicator for the concentration of bureaucratic power in the economy or, put differently, s can be viewed as the extent to which the utility of the non-government sector enters the utility function of bureaucrats.[13]

A. Households

Households earn wages and receive interest income. They purchase goods for consumption and save by accumulating additional assets. The current household head maximizes "family utility" by taking into account the well being of all his descendants; we thus face an infinite horizon maximization problem. In the setting considered here, there are two types of households: government employees and private sector employees, the difference between the two types being that the former have the power to impose bribe payments on investment, thereby generating an additional source of income.

Labeling the population growth rate n and normalizing the number of adults at time 0 to unity, the total adult population at time t is $L(t) = e^{nt}$, of which $L_g(t) \equiv se^{nt}$ agents are government employees. The subscripts g and p denote variables referring to the government and private sector employees, respectively and are omitted whenever no ambiguity arises. Lower case symbols represent variables per adult person; for example, $C(t)$ is total consumption at time t, while $c(t) \equiv C(t)/L(t)$.

Households maximize overall utility, U, which can be represented as a weighted sum of all future discounted utility flows, $u(c)$:

$$U = \int_0^\infty u[c(t)]e^{nt}e^{-\rho t}dt, \tag{1}$$

where $\rho > 0$ is the rate of time preference. We assume that $\rho > n$ to ensure that U is bounded for constant c and that $u(c)$ has the usual properties and satisfies the Inada conditions.[14]

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[12] Strictly speaking, bribes, as compared to taxes, are associated with higher uncertainty and require costly efforts to avoid detection (see section II). Adding uncertainty to the model, however, would only strengthen the main results.

[13] Aside from analyzing corruption, this model can be easily modified to apply to the more general case where a fraction of the population has the revocable power to impose a burden on the entire population.

[14] Thus, $u'(c) > 0, u''(c) < 0, \lim_{c\to\infty} u'(c) \to \infty$, and $\lim_{c\to 0} u'(c) \to 0$.

Government employees have three sources of income: labor income, interest income, and bribes.[15] Agents are competitive, i.e., they take the wage rate, w, and the interest rate, r, as given and supply inelastically 1 unit of labor services per time unit. The bribe is a fraction γ of gross investment $I = \dot{K} + \delta K$, where δ is the rate of depreciation. The corrupt bureaucrat is detected and punished with probability $\bar{p}$, increasing with the extent of corruption, γ, and the monitoring technology of the society, M, so that $\bar{p} = \bar{p}(\gamma, M)$, with $\partial\bar{p}/\partial\gamma > 0$, and $\partial\bar{p}/\partial M > 0$. Conversely, let $p \equiv 1 - \bar{p}$ denote the likelihood of not being detected. Upon being caught, the corrupt bureaucrat foregoes his bribe payment and is forced to pay a penalty, z.[16] The expected flow budget constraint faced by the government employee household can thus be written:

$$\dot{a} = w + ra + \frac{\gamma p(\gamma, M)}{s}(\dot{k} + [n + \delta]k) - [1 - p(\gamma, M)]z - c - na, \tag{2}$$

where a denotes the household's total i.e. domestic and foreign assets, and a dot over a variable marks a time derivative. Thus, the increase in assets per capita equals the sum of the three income types less per capita consumption and an adjustment term for population growth. The expected bribe receipt, the third component in Eq. (2), amounts to γ times gross investment weighted by the probability of not being caught divided by the number of government employees.[17]

To rule out Ponzi schemes, we impose a constraint on the amount of borrowing by households, the so-called transversality condition, ensuring that the present value of their assets remains nonnegative:

$$\lim_{t\to\infty}\left\{a(t)\exp\left[-\int_0^t (r(v) - n)dv\right]\right\} \geq 0 \tag{3}$$

Maximization of U in Eq. (1) subject to the budget constraint in Eq. (2), the stock of initial assets, $a(0)$, and the credit constraint in Eq. (3) yields the following present-value Hamiltonian:

$$H = u(c)e^{-(\rho - n)t} + v\left[w + ra + \gamma p(\dot{k} + [n + \delta]k)/s - (1 - p)z - c - na\right]. \tag{4}$$

The first order conditions for a maximum are

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[15] It proves convenient to start with the government employees' utility maximization problem, as the private sector agents' problem turns out to be a special case thereof.

[16] If we imposed a penalty as a function of the wage rate, e.g., through a loss in retirement benefits, our model would show that, *ceteris paribus*, higher wages deter corruption.

[17] Note that $\dot{K}/L = \dot{k} + nk$ and therefore $(\dot{K} + \delta K)/L_g = (\dot{k} + [n + \delta]k)/s$.

$$\frac{\partial H}{\partial c} = 0 \Rightarrow v = u'(c)e^{-(\rho-n)t}, \tag{5}$$

$$\frac{\partial H}{\partial a} = -\dot{v} = -(r-n)v \tag{6}$$

$$\frac{\partial H}{\partial \gamma} = 0 \Rightarrow \gamma^* = \frac{1}{2\bar{p}(1,M)} - \frac{zs}{\dot{k} + [n+\delta]k}. \tag{7}$$

While Eq. (5) and (6) describe the optimal consumption pattern, Eq. (7) derives the optimal extent of corruption, γ^*, for the atomistic bureaucrat under the simplifying assumption that $\bar{p}$ is a linear function of γ so that $\bar{p} = \bar{p}(1,M)\gamma$ and $\partial\bar{p}/\partial\gamma = \bar{p}(1,M)$ is independent of γ. As $\partial\bar{p}/\partial M > 0$, an increase in the penalty or in the monitoring effort, z and M respectively, or a reduction in the concentration of bureaucratic power, 1-s,[18] decreases the utility maximizing extent of corruption for the bureaucrat. On the other hand, a more capital intensive mode of production—e.g., through a larger share of relatively capital intensive natural resource extraction activities in the economy—has the opposite effect, leading to a rise in corruption.

Following common practice in the literature, we assume that $u(c)$ takes the form of a constant intertemporal elasticity of substitution function (CIES) function,[19] in which case the optimal consumption path, derived by differentiating Eq. (5) with respect to time and using Eq. (6), becomes

$$\dot{c}/c = (1/\theta)(r-\rho). \tag{8}$$

This standard Euler equation implies that an interest rate greater than the rate of time preference leads to an increasing consumption pattern over time, with the opposite true for interest rates

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[18] Intuitively, as the number of government employees increases, bureaucrats have more colleagues with whom the proceeds from bribes must be shared, effectively reducing the expected gain from corruption. If simultaneously, the risk of detection remains unaffected ($\bar{p}$ is independent of s, as assumed here), then unambiguously the optimal bribe is a negative function of the size of the public service. In a closed economy setting, where public servants and private sector employees differ only in their capacity to impose bribes, and where both groups are shareholders, an increase in s raises the costs of corruption borne by government employees (they are more and more "taxing themselves") and induces them to internalize the distortionary effects caused by corruption. This argument is similar to the one put forward by Shleifer and Vishny (1993), and it should not be taken to mean that a reduction in corruption can be brought about by a larger government sector, but only that the inefficiency consequences of corruption diminish as s increases.

[19] That is, $u(c) = \left(c^{1-\theta} - 1\right)/(1-\theta)$, and therefore the elasticity of marginal utility equals the constant -θ and the elasticity of substitution is $\sigma = 1/\theta$ with $\theta > 0$.

smaller than the rate of time preference. On the contrary, agents prefer a constant consumption stream if the interest rate happens to equal the rate of time preference. Note that, as Eq. (8) is independent of γ or s, it applies to both government and civil sector employees, and it stands for the consumption pattern of the aggregated economy.[20]

B. Firms

Firms produce the economy's single good, Y, employing a production technology with neoclassical properties, i.e. constant returns to scale in K and L and positive and decreasing marginal products. For ease of presentation, the level of technology is assumed to be independent of time. The production technology can be written as

$$Y = F(K, L) \tag{9}$$

The firms' net cash flow is defined as sale proceeds net of wage payments and investment costs, CI:

$$\Pi = F(K, L) - wL - CI\,, \tag{10}$$

where CI equals the physical cost of investment plus the "unavoidable" bribe payment, i.e.,

$$CI = I[1+\gamma].$$

The firm's objective is to maximize the present value of net cash flows between time 0 and infinity by an appropriate choice of L and I, subject to $\dot{K} = I - \delta K$ and an initial value $K(0)$. Let $\bar{r}(t)$ be the average interest rate between times 0 and t, i.e., $\bar{r}(t) \equiv (1/t)\int_0^t r(v)dv$, in which case the firm's optimization problem can be represented by the following Hamiltonian:

$$J = e^{-\bar{r}(t)t}\{F(K, L) - wL - I(1+\gamma)\} + v(I - \delta K) \tag{11}$$

In Eq. (11), v is the shadow price associated with installed capital in units of time 0 output, i.e., the present-value shadow price of installed capital. The current-value shadow price of installed capital, q, is then $q = v/e^{-r(t)t}$. Firms are competitive, taking w and γ as given, and hence the first order conditions are:[21]

[20] Given their extra sources of income, government employees still enjoy a level of consumption higher than private sector employees.

[21] The transversality condition is $\lim_{t\to\infty}(vK) = 0$.

$$\frac{\partial J}{\partial L} = 0 \Rightarrow F_L(K,L) = f(k) - kf'(k) = w, \tag{12}$$

$$\frac{\partial J}{\partial I} = 0 \Rightarrow q = 1+\gamma, \text{ and} \tag{13}$$

$$\dot{v} = -\frac{\partial J}{\partial K} \Rightarrow \dot{q} = (r+\delta)q - f'(k), \tag{14}$$

where $f(k)$ is the intensive form of the production function. Eq. (12) represents the usual result that the marginal product of labor equals the wage rate, and Eq. (13) shows that the shadow price of installed capital exceeds unity by the extent of corruption. Eq. (14) can be rewritten to yield $r = f'(k)/q - \delta - \dot{q}/q$, which differs from the conventional results, $r = f'(k) - \delta$ by the terms in q. This equation for r indicates that – with a given world interest rate – the steady state capital stock will be lower in the presence of corruption as $q > 1$ for $\gamma > 0$. Using Eqs. (7) and (13), as well as $\dot{k} = i - (n+\delta)k$, the motion equation for $\dot{k}$ can be derived as a function of the model's parameters and the shadow price, q:

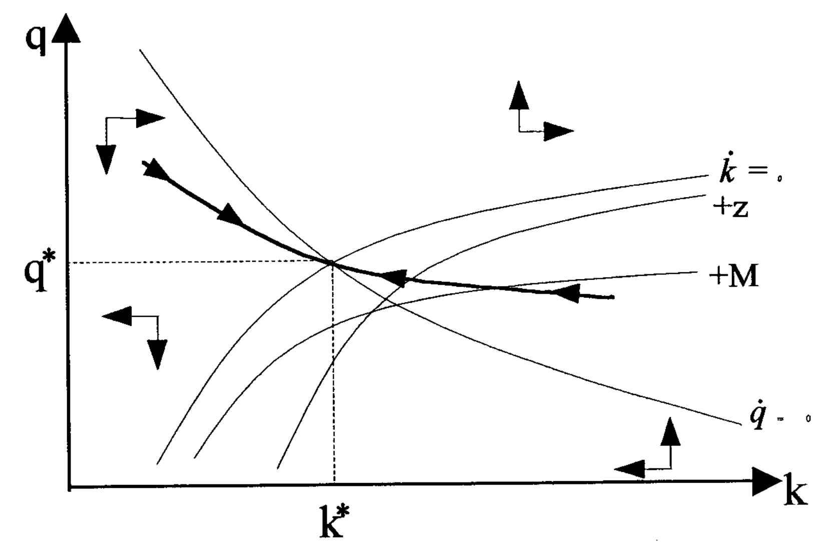
$$\dot{k} = \frac{zs\,\overline{p}(1,M)}{2\overline{p}(1,M)(1-q)+1} - (n+\delta)k \tag{15}$$

Eqs. (14) and (15) constitute a two-dimensional system of differential equations in k and q. Note that in the small open economy setting, the path of $r(t)$ is independent of savings or the capital stock, and thus, the consumers' optimization problem. The condition $\dot{k} = 0$ can be used to derive

$$q = 1 + \frac{1}{2\overline{p}(1,M)} - \frac{zs}{2(n+\delta)k}. \tag{16}$$

Thus, the value of q exceeds 1 for $k > zs\,\overline{p}(1,M)/(n+\delta)$. As indicated above, a higher q^* is tantamount to a lower steady state capital stock k^*. The phase diagram in Figure 1 illustrates the steady state and the transitional dynamics of the system. It is straightforward to show that the

Figure 1. A Small-Open Economy With Corruption

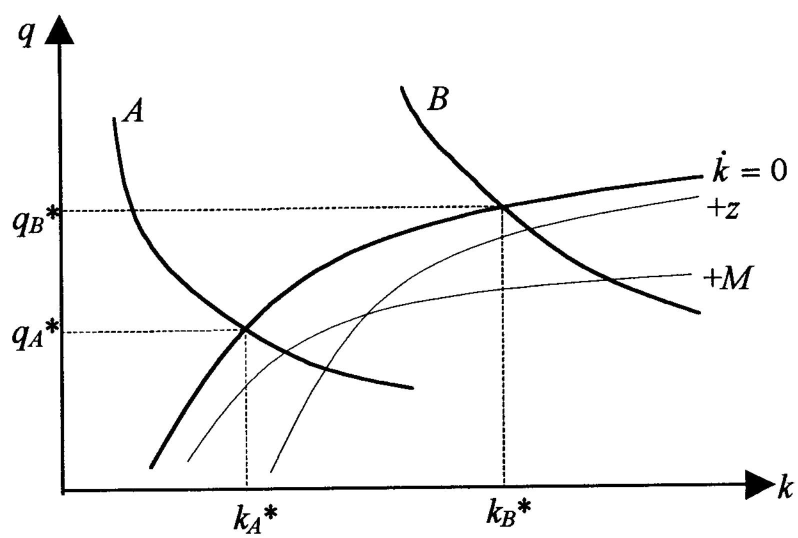


system exhibits saddle-path stability, the stable arm being depicted by the thick solid line with arrows.

Figure 1 also demonstrates the economic ramifications of fighting corruption, be it through improved monitoring (the line labeled as "$+M$") or enhanced incentive schemes (the line labeled as "$+z$"). Both policies lead to a reduction in the steady-state shadow price of capital and, *ipso facto*, an increase in the steady-state capital stock and also steady-state output. Likewise, fighting corruption implies a higher speed of convergence and thus a higher growth rate of per capita output during convergence to the steady state, as the convergence coefficient can be shown to depend positively on z and M. Conversely, economies with weaker institutional control, or with incentive schemes that do not effectively discourage bribery, tend to grow slower.

Another noteworthy feature of the model is the implication that the impact of the two anticorruption policies depends on the state of economic development or, more precisely, on the capital intensity of the economy. Figure 2 depicts two economies: A is characterized by low values of steady-state q and k, whereas B corresponds to high values of steady-state q and k, so that, generally speaking, they could be thought of as a developing and developed economy, respectively. As Figure 2 shows, the increased penalty generates a larger increase in the

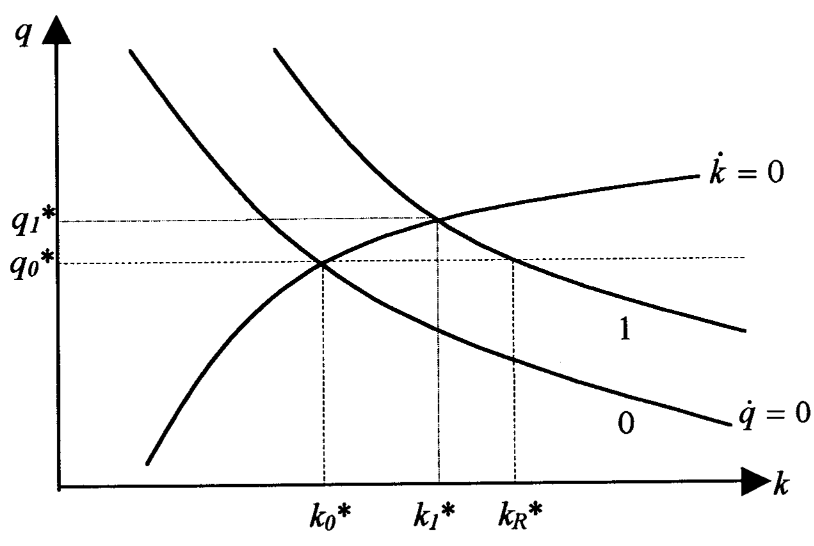
Figure 2. The Effects of Anti-Corruption Policies



steady-state capital stock, and thus output, in the developing economy than the improved monitoring technology, whereas the opposite is true for the developed economy.[22] Thus, the battle against corruption should be fought with different weapons depending on the development of the economy. The different impact of the two policies stems from the fact that an increase in M, in raising the likelihood of being caught leads to two separate effects: a reduction in the expected bribe payment and an increase in the expected penalty. As the bribe payment relative to k increases with k, the potential loss for the corrupt government employee through enhanced monitoring is relatively higher for large k.

The model also yields insights on the economic effects of a natural resource discovery, viewed as a technology shock shifting the $\dot{q} = 0$ curve outwards; in Figure 3, the movement is from 0 to 1. Two observations stand out. First, the technology-induced increase in the steady-state level of both capital stock and output is reduced as a consequence of corruption. Without corruption, the $\dot{k} = 0$ curve would be a horizontal line through q_0* and the outward shift of the $\dot{q} = 0$ curve would leave q* unaffected while increasing k* to k_R*, instead of k_1*. It is straightforward to show that this result carries over to the output growth rates during the transition to the new steady state. Second, due to the curvature of the $\dot{k} = 0$ curve, the negative impact of corruption differs depending on the initial steady-state of the economy with the effect being more pronounced in less capitalized, i.e., less developed, countries. The reason for this nonlinearity follows from Eq. (7) where it can be seen that a given change in the capital stock has a higher effect on the extent of corruption at low levels of k than at higher levels of k.

Figure 3. The Effect of an Increase in Natural Resources



[22] It may also be noted that the increase in output resulting from an anti-corruption policy based on increased penalties depends negatively on the concentration of bureaucratic power, 1-s.

This property of the model also suggests that the opportunity costs of corruption, in terms of relative output (growth) foregone, are related to the degree of capital intensity. More specifically, the shortfall of output (growth) from its potential due to the existence of corruption is more pronounced after an increase in (labor intensive) food production than after an increase in (capital intensive) oil extraction. In the empirical section, we investigate dissimilarities in the growth effects of the different resource extracting industries by disaggregating the natural resource variable into its components.

The implications of our model for the subsequent empirical investigation can be summarized in three points. First, the endogeneity of corruption has to be accounted for, otherwise the empirical estimates of the growth effects of natural resource abundance might be biased downward. Second, the various sub-categories of natural resources potentially differ in their effect on corruption and growth, and some insights might be gained by disaggregating the natural resource variable into its components. Third and finally, the level of corruption, and consequently the growth effect of natural resources, also depend on institutional factors like the concentration of bureaucratic power, the monitoring technology, and the penalty system.

IV. Empirical Results

A. Data

The working definition of corruption usually invokes some notion of illegality, and despite the fact that bribery can obviously take place in the private sector, typically focuses on the use of public office for private gain. Notwithstanding the obvious difficulties in measuring illegal activities, several indices that attempt to measure some facet of corruption are available from "investment advisory services", such as the Economist Intelligence Unit (EIU), International Country Risk Guide (ICRG), and Business and Environmental Risk Intelligence (BERI). The typical clients for these surveys are reportedly banks, multinational companies and other international investors, and the definitions of corruption used by the rating agencies tend to focus on measuring the degree to which business transactions involve corruption or "questionable" payments. Mauro (1995) used data from an agency now incorporated into the EIU, while Keefer and Knack (1993) and Easterly and Levine (1996) used data from both ICRG and BERI. More recently, the non-governmental organization Transparency International has made widely available its collection of surveys on levels of corruption in various countries. Fortunately, the data for the various indices, including measures of various aspects of bureaucratic efficiency, are highly correlated, as detailed in Mauro (1995).

As a measure of corruption, we use the ICRG corruption index originally introduced into the academic literature by Knack and Keefer (1995). The index is scored on a scale 0-6 with lower scores indicating that "high government officials are likely to demand special payments" and "illegal payments are generally expected throughout lower levels of government" in the form of "bribes connected with import and export licenses, exchange controls, tax assessment, policy protection, or loans" (Knack and Keefer, 1995, p. 225).

The variables on the quality of legal and political institutions and on political instability are taken from Barro and Lee (1994), and are originally from ICRG and Banks (1979). As a measure of the quality of legal and political institutions, we use an index on the "rule of law" which subjectively measures the degree to which the citizens of a country are willing to grant to the established institutions the authority to make and implement laws and adjudicate disputes. Higher scores on the scale 0-6 indicate "sound political institutions, a strong court system, and provisions for an orderly succession of power" (Knack and Keefer, 1995, p. 225). The political instability variable, revolutions and coups, is the period average of revolutions per year and political assassinations per million inhabitants per year.

The data on natural resource exports as a share of GNP are originally from Sachs and Warner (1995a), with the definition of natural resources following convention in including SITC categories 0 (live animals and all unprocessed and processed food products), 1 (beverages and tobacco), 2 (inedible crude materials except fuels), 3 (mineral fuels, lubricants and related materials), 4 (animal and vegetable oil and fats), and 68 (non-ferrous metals). The disaggregated data on exports of fuel, minerals, agricultural and food products were gathered from the World Bank's World Development Indicators (WDI).

We measure trade policy stance by the Sachs and Warner (1995a) trade openness variable, defined as the fraction of years (over the period 1970-90) that a particular economy is classified as open. In any one year, an economy is considered open if none of the following five characteristics are present: tariffs exceeding 40 percent; nontariff barriers covering more than 40 percent of trade; a black market premium more than 20 percent relative to the official exchange rate, on average; a centrally-planned economic system; or a state monopoly on major exports.

The dummy variable on public participation in fuels and ores is defined to equal 1 for countries with public sector involvement in the particular industry, 0 otherwise, and was constructed from information on industry coverage of public enterprises found in Table 3 of Short (1984). The measure of country-specific commodity price variability was calculated as the standard deviation, over the period 1970-90, of WDI price indexes for fuel, ores, agricultural and food products weighted by each country's share of exports comprised by the specific commodity. The remainder of the data is taken from Sachs and Warner (1995a).

B. Regression Results

This section considers the empirical determinants of corruption and its effect on growth. Two key propositions from the theoretical model presented above are that corruption (1) takes the form of rent-seeking activities, with the level of corruption positively related to the incidence of high rent activities and negatively related to monitoring efforts, and (2) lowers the steady state income level, thereby reducing the economy's growth rate. Consistent with our interest in the role of natural resources, we endogenize corruption within the growth-regression framework of Sachs and Warner (1995a). The two-equation econometric specification is then

$$Corruption_i = Z\theta + \delta_1 Natural\ Resources_i + \delta_2 Trade\ Openness_i + \delta_3 Rule\ of\ Law_i + \delta_4 Political\ Instability_i + e_{1,i}$$

$$\frac{\ln(Y_i^{1990} / Y_i^{1970})}{20} = X\beta + \alpha_1 \ln Y_i^{1970} + \alpha_2 Corruption_i + \alpha_3 Natural\ Resources_i + e_{2,i},$$

where Y_i^t stands for country i's GDP per economically active person at time t. In the corruption equation, the availability of rent-seeking opportunities is measured by the structure of the economy (particularly endowments of natural resources) and the degree of openness to trade; while monitoring efforts by the government are measured by the strength of the institutions charged with the implementation of laws (rule of law) and the level of political instability (the incidence of revolutions and coups). The set of additional conditioning variables, Z, includes the rate of economic growth over the period 1970-90; a measure of ethnic diversity, the ethnolinguistic fractionalization index introduced by Mauro (1995); and a dummy variable for sub-Saharan African countries. We also test for robustness, in the sense of Levine and Renelt (1992), by the addition of a wider set of variables, as detailed in the footnotes to the relevant tables.

Economic growth, particularly rapid economic growth, entails substantial changes in production methods and social relationships, including changes in the importance of different industries, skills and business practices. At the same time, there is no guarantee that the evolution of the new institutions (be they government agencies, social or professional organizations, or even social norms) required to either manage or support these changes will take place in concert with the changes themselves. Consider, for example, the following set of stylized facts. On its path through economic development, a low-income country begins to invest in larger capital-intensive natural resource projects. With government revenues increasing and institutional development lagging behind the pace of change in the economic structure, conditions become auspiciously favorable for engagement in revenue raising activities of the directly unproductive type of Bhagwati (1982).

In the specific case of rapid economic growth brought on by oil and mineral discoveries, the accrual of a majority of the revenue directly to the government is liable to exacerbate the incidence of rent-seeking behavior, as claimed by Kahn (1984) for the case of Nigeria. In contrast, economic growth driven by the acquisition of human capital would likely generate fewer easily-appropriable rents, and would in any case, tend to simultaneously lead to an improvement in the quality of the institutions (to the extent that basic skills and leadership would be enhanced by the higher level of human capital). As a corollary, we would also posit that more labor-intensive natural resources, such as food and agricultural products, would tend to generate fewer rents and be associated with less corruption. Given the expected differences in behavior for the different components of natural resources, we split the natural resources variable of Sachs and Warner (1995a) into its four components (fuel, ores, agriculture and food), originally adding each component as a separate variable. We also add the rate of economic growth, along with the different components of natural resources, in order to control for the effects of non-resource based rapid growth.

The rent-seeking literature suggests that the incidence of bribery is also likely to be associated with the extent of trade regulations, the quality of legal and political institutions, and the level of political instability. Ceteris paribus, we would expect that an economy more open to trade (a higher value for trade openness), with stronger institutions (a higher score for rule of law), and with a higher degree of political stability (a lower value for political instability) would tend to have less corruption.

The inclusion of the ethnic diversity variable is an attempt to assess whether societal divisions along ethnic and linguistic lines contribute to rent-seeking behavior. It may be, for example, that the prevalence of strong family ties, together with a lack of national identity and the absence of accountability of government officials, leads people in positions of power to favor friends and relatives, at the expense of the greater public good. The impact of ethnic diversity may also be related to the theoretical prediction of our model on the effect of bureaucratic power concentration. It may be, for example, that an ethnic group in power will find it easier to pass on the costs of bribe payments to other ethnic groups, reducing the incentive for the former to internalize the costs of corruption.[23] Under both explanations, a more ethnically diverse society (a higher value on the ethnic fractionalization measure) would be expected to have more corruption.[24]

Finally, the rationale for the inclusion of the Africa variable is straightforward: corruption is widely regarded as endemic, and inherently different, in certain parts of the world, particularly in Africa (Shleifer and Vishny, 1993, p. 611). These types of explanations are not well grounded in economic theory, and presumably, if the set of conditioning variables adequately captures the incidence of corruption, dummy variables for any regional grouping should be statistically insignificant (enhancing the applicability of policy prescriptions).

For the growth equation, we follow Sachs and Warner (1995a) in testing our propositions in the context of the trade policy regime. Our main variables of interest are corruption and natural resources. Our theoretical model predicts that more corruption is, ceteris paribus, associated with lower rates of growth, while the original Sachs and Warner (1995a) results suggest that an abundance of natural resources tends to reduce economic growth. In endogenizing corruption, we impose an exclusion restriction on the original Sachs and Warner (1995a) growth specification: rule of law, which they originally include as an explanatory variable, is posited to work only through corruption.

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[23] The effect of bureaucratic concentration (and, more specifically, the degree of internalization of the costs of corruption) may otherwise be proxied by the share of government employment in total employment, or by the share of government current expenditures in GDP.

[24] It may also be that leadership, which Tanzi (1998) suggests is associated with less corruption, is more likely to flourish in more ethnically homogeneous societies.

The set of additional conditioning variables, *X*, includes as in Sachs and Warner (1995a), the period average for the ratio of investment to GDP, the level of trade openness over the period, and the change in the terms of trade over the period. For our specification, we also include a measure of the country-specific variability in commodity prices. The rationale for the first three variables is straightforward and clearly articulated in Sachs and Warner (1995a). The addition of price variability is intended to control for the potentially negative impact of commodity price fluctuations, the rationale for which is clearly articulated in the literature on the Dutch disease, as reviewed above. *Ceteris paribus*, we would expect that an economy with a higher investment ratio, a more open trade policy, with more favorable changes in the terms of trade (higher value for terms of trade), and facing less commodity-based export price variability (lower value for commodity price variability) would tend to have a higher rate of growth.

In the context of the neoclassical growth model, the incidence of natural resources is interpreted as an exogenous technology shock affecting growth through the aggregate production function. By raising the steady state level of income and leaving the economy farther from its long-run target, natural resources should, ceteris paribus, stimulate economic growth (intuitively, the economy can always stay with the original technology). However, as highlighted in our discussion on the direct (Dutch disease) and indirect (institutional impact) effects, some of the characteristics of resource-led growth can induce a net negative effect on growth, even as average income increases. That is, the initial increase in production (and growth) may be accompanied by policy and institutional changes that, after some time, leave the steady state level of income closer to the current level of income, thereby reducing the rate of economic growth over the medium term. Given the specification for the corruption regression, we can now assess the strength of corruption as a transmission mechanism from natural resource abundance to economic growth.

The next two sections present the results for the corruption and the growth regression, while the third section provides further evidence on the role of natural resources in the growth process.

Corruption Regression

Table 1 below presents the results using the corruption index as the dependent variable, with a high score – on a 0-6 scale – indicating less corruption. The first regression suggests that natural resources should be decomposed into just two variables, 'Fuel & Ores' and 'Agriculture & Food', rather than the usual four components. Not only are the signs on Fuel and Ores (Agriculture and Food) consistently negative (positive) for a variety of specifications, but F-tests on the equality of coefficients uniformly fail to reject two null hypotheses:

$$H_0:\ \delta_{\text{Fuel}} = \delta_{\text{Ores}}\text{; and}$$
$$H_0:\ \delta_{\text{Agriculture}} = \delta_{\text{Food}}.$$

Table 1. Corruption Regression 1/ 2/ 3/ 4/

	Corr1	Corr2	Corr3	Corr4	Corr5
GDP Growth 70-90	-0.21 *	-0.22 *	-0.22 **	-0.03	
Initial Income				0.62 *	0.75 ***
Fuel_1970	-2.85 *				
Ores_1970	-5.47 ***				
Fuel&Ores_1970		-4.19 ***	-4.16 ***	-4.02 ***	-2.73 ***
Agriculture_1970	4.79				
Food_1970	4.55 *				
Agriculture&Food_1970		4.81 ***	4.12 **	4.54 ***	4.36 ***
Rule of Law	0.68 ***	0.69 ***	0.61 ***	0.43 ***	0.33 ***
Revolutions and Coups			-1.09 **	-1.20 **	-1.38 ***
Trade Openness	1.19 **	1.11 **	1.23 ***	0.93 **	1.18 ***
Fraction	-0.002	-0.003	-0.002	0.002	0.001
Africa	0.26	0.21	0.09	0.51	0.60
Constant	0.98 **	1.00 ***	1.43 ***	-3.63	-4.53 **
Adjusted R-Sq.	**0.74**	**0.74**	**0.75**	**0.79**	**0.79**
No. Observations	**72**	**72**	**72**	**72**	**72**

1/ Specifications including GDP Growth rate are estimated using 2SLS with GDP Growth rate endogenized.

2/ Coefficients significant at the 1%, 5%, and 10% level of significance are indicated with a ***, **, and *.

3/ Qualitative results are robust to the presence/absence of a wide set of additional variables, including bureaucratic quality, arms imports as a percentage of GDP, regional dummies, indicators on the incidence of civil conflicts, indicators on the state of property rights, foreign aid flows, share of government current expenditure in GDP, and cross variables between 'rule of law' and regional dummies and between natural resources and regional dummies.

4/ Qualitative results are robust to estimation by a tobit procedure to account for both the upper and lower limits in the dependent variable.

The suggested groupings are in line with the general characterization of fuel and ores as relatively capital intensive, and agricultural and food industries as relatively labor intensive, and the obtained results are in line with earlier theoretical predictions: capital (labor) intensive natural resource industries tend to induce a higher (lower) level of corruption, ceteris paribus.

The coefficient on 'Trade Openness' identifies corruption as a channel through which trade restrictions affect growth, consistent with the rent-seeking literature. The obtained results suggest that countries more open to external trade (i.e., with fewer trade restrictions), indicated as a high score on the openness measure, tend to have less corruption, consistent with the explanation from the rent-seeking literature that regulations on foreign trade tend to generate both substantial rents and rent-seeking behavior.

The results also support the hypothesis that monitoring efforts tend to dampen corruption. Sounder institutions, indicated as a high score on rule of law, tend to be associated with lower corruption, while more political instability, indicated as a high score on revolutions and coups, tends to foster a higher level of corruption.

The conclusions on the role of both rent-seeking opportunities and monitoring are robust, both in the sense of Levine and Renelt (1992) and with respect to estimation technique. As detailed in the footnotes to Table 1, we tested for robustness by the inclusion of a series of variables commonplace in the economic growth literature, and the qualitative conclusions remained intact. We also estimated the regressions shown in table 1 by a tobit procedure, to account for both the upper and the lower limits in the dependent variable, and again the results remain qualitatively unchanged.

Three other results are worth noting. First, it appears that the level of corruption is not inherently affected by ethnic diversity, contrary to the suggestions in Mauro (1995) and Tanzi (1998). On a related level, we find no evidence for the predicted effect of bureaucratic power concentration: the results in Table 1 are robust to the addition of a variable on government current expenditures as a share of GDP. Second, it appears that corruption in Africa takes the same form as elsewhere: once account is taken of the key determinants of the level of corruption, the coefficient on the Africa dummy variable is insignificantly different from zero. Third, the coefficient on the GDP growth rate suggests that rapid growth leads to more corruption, a result robust to instrumenting long-run growth with initial income. From our previous discussion, the inference is not that a lower growth rate is somehow to be preferred but simply that rapid economic progress, if its beneficial effect is to be fully felt, requires special attention to be paid to the social and institutional fabric.

Growth Regression

The results for the growth regression are presented in Table 2. The first regression reproduces equation (4) of Sachs and Warner (1995a) while the others endogenize corruption. The third and fourth regressions specifically account for the possible effects of commodity price volatility, measured by the standard deviation of the WDI commodity price indexes (fuel, ores, agriculture and food) weighted by the country's export share of the specific commodity. The rationale for including this variable is that commodity prices are renowned for their volatility which tends to, *inter alia*, increase *ex-ante* uncertainty and cause substantial variation in government revenues.

Table 2. Growth Regression 1/ 2/ 3/

	SW4	**LW1**	**LW2**	**LW3**
Corruption	...	0.43 **	0.71 ***	0.72 ***
Initial Income	-1.47 ***	-1.50 ***	-1.90 ***	-1.90 ***
Natural Resources	-7.19 ***	-7.51 ***	-6.29 ***	-6.41 ***
Trade Openness	1.69 ***	1.55 ***	0.88 *	0.90 *
Investment/GDP 4/	0.94 ***	0.73 *	0.31	0.31
Terms of Trade	0.16 ***	0.19 ***	0.30 ***	0.29 ***
Rule of Law	0.30 ***	...	...	...
Africa	...	...	...	-0.04
Commodity Price Variability in Africa	...	...	-0.05 **	-0.05
Commodity Price Variability in non-Africa	...	...	-0.01	...
Constant	10.29 ***	10.78 ***	14.86 ***	14.80 ***
Adjusted R-Sq.	**0.65**	**0.66**	**0.65**	**0.65**
No. Observations	**78**	**72**	**72**	**72**

1/ SW4 refers to regression (4) in Sachs and Warner (1995). LW1-LW3 refers to our regressions estimated using 2SLS with Corruption endogenized. A lower score on the corruption index indicates less corruption.
2/ Coeficients significant at the 1%, 5%, and 10% level of significance are indicated with ***, **, and *.
3/ Qualitative results are robust to the presence/exlcusion of additional variables including political indicators on the incidence of civil conflicts and revolutions; institutional indicators on the state of property rights; and public sector participation in the petroleum and mineral extraction industries.
4/ Qualitative results are robust to instrumenting the investment ratio with the relative price of investment goods in 1970 (log of the ratio of the investment deflator to the overall GDP deflator in 1970).

Consistent with the growth literature, the conditional convergence hypothesis is confirmed by the negative coefficient on initial income; the positive impact of trade (or the absence of trade restrictions) is confirmed by the positive coefficient on trade openness; and positive terms of trade shocks are associated with higher growth. In the context of the neoclassical model, these results confirm that countries converge faster the farther they are from their own steady state. Consistent with predictions from the Dutch disease literature, our results suggest that natural resource abundance tends to reduce long-run growth rate. Unlike other studies, however, we find no evidence that, *ceteris paribus*, the growth process in Africa is different from other parts of the world. In fact, the fourth regression, LW3, suggests that the addition of Africa leads simply to some multicollinearity with the price variability measure, reducing each variable to insignificance.

In accordance with our theoretical model, long-term growth is negatively affected by the level of corruption: the average annual GDP growth rate is raised by some 1.4 percentage points with a one-standard deviation improvement in the corruption ranking (equivalent to Venezuela reducing its corruption to the level of Chile, Chile to the United States or Kenya to Taiwan). From the results for the corruption regression, we can identify three mechanisms for such an improvement in corruption rankings: trade policy, quality of institutions and political stability. Below, we present suggestive calculations for the impact on both corruption and growth of a change in the first two mechanisms. Table 3 considers the impact of a more open trade policy while table 4 estimates the impact of a combined policy effort: a more open trade policy and an improvement in the quality of institutions.

Table 3. Improvements in Trade Regime

From:	To:	Effect on Corruption: 1/	Effect on Growth: 2/
Venezuela	Chile	0.66	0.95
Chile	USA	0.52	0.74
Kenya	Taiwan	1.09	1.55
Cameroon	Taiwan	1.23	1.75
Cameroon	Chile	0.71	1.01
Nigeria	Chile	0.52	0.74

1/ One standard deviation is equal to 1.93 in the corruption ranking.
2/ One standard deviation is equal to 1.95 in the annual average (1970-90) GDP growth rate.

The implication from table 3 is the following: had Venezuela's trade policies been as liberal as Chile's over the period 1970-90, Venezuela would have experienced a significant improvement in the corruption ranking (equivalent to 35 percent of one standard deviation), and an increase of close to 1 percent in the average annual GDP growth rate; and if Cameroon had similarly emulated Chile, Cameroon's corruption ranking and growth rate would have improved by similar magnitudes.

Table 4. Improvements in Trade Regime and Rule of Law

From:	To:	Effect on Corruption: 1/	Effect on Growth: 2/
Venezuela	Chile	1.88	1.81
Chile	USA	1.13	1.17
Kenya	Taiwan	3.53	3.28
Cameroon	Taiwan	3.06	3.05
Cameroon	Chile	1.93	1.88
Nigeria	Chile	2.96	2.03

1/ One standard deviation is equal to 1.93 in the corruption ranking.
2/ One standard deviation is equal to 1.95 in the annual average (1970-90) GDP growth rate.

In this case, if Venezuela had opened its economy and strengthened its legal institutions to the same degree as Chile, Venezuela's corruption ranking would have improved by close to one standard deviation and its average annual GDP growth rate would have risen by some 1.8 percentage points; similar policy actions for Cameroon would have had broadly the same impact.

It is also instructive to evaluate the effects of these policy improvements on the level of income. Table 5 compares the actual and the projected level of income in 1990 for the countries implementing the policy changes detailed in the previous two tables.

Table 5. Improvements in Policy Stance 1970-90:
Projected Impact on 1990 GDP per Economically Active Person (EAP)

		1990 GDP per EAP 1/		
		Actual	Including Improvement in: 2/	
From:	To:		Trade Regime	Trade Regime & Rule of Law
Venezuela	Chile	10,411	12,577	14,956
Chile	USA	6,806	7,895	8,609
Kenya	Taiwan	1,918	2,616	3,700
Cameroon	Taiwan	2,434	3,456	4,482
Cameroon	Chile	2,434	2,980	3,543
Nigeria	Chile	1,963	2,277	2,948

1/ GDP per EAP for the country implementing the policy change; in current US dollars.
2/ Policy regime improvements from Table 3 (trade) and Table 4 (trade and rule of law).

That is, if Cameroon had emulated Taiwan in terms of trade policy and institutions over the period 1970-90, Cameroon's level of income per economically active person would have been, by 1990, more than US$2,000 higher than the observed outcome, an increase of some 84 percent in the purchasing power of the average Cameroonian!

Operationally, the normative implication is that to attenuate the extent of corruption and to foster significant improvements in the standards of living, policy makers should focus their efforts on liberalizing the external trade regime and enhancing the quality of legal and political institutions. Given our finding that neither the corruption nor the growth process have specific regional dimensions, this recommendation remains as valid in Africa as in any other region of the world.

Natural Resource Components

Although Table 1 confirms that natural resources affect economic growth partly through their effect on corruption, the regressions in Table 2 reveal that the Sachs and Warner (1995a) proposition on the negative effect of natural resources on growth remains intact, even after accounting for the endogeneity of corruption, and the effects of commodity price variability and trade liberalization. To further investigate the impact of natural resources on growth, we re-estimate the previous growth equation by disaggregating natural resources into its constituent components, accounting for the possible effects of the (non-random) regional distribution of natural resource endowments, and also controlling for the effects of government consumption.

There are substantial differences in the characteristics of the four components of commodities originally grouped by Sachs and Warner (1995a) under natural resources. Consider not just the aforementioned differences with respect to factor intensity, but also differences in ownership (with fuel production most often dominated by foreign capital but with public enterprises playing a significant role in mining), the longer extraction time required for capital recovery in both fuel and ores, and the higher export share for fuel and ores whereas food and agricultural raw material production is primarily oriented to the domestic market (although this pattern may change with increases in income).[25] Furthermore, the low productivity sectors agriculture and food tend to tie a large share of the labor force to rural areas hampering labor migration to more urban areas with potentially more productive occupations and thereby limiting a country's growth potential. To allow the effects of each category to be different, we again disaggregate the natural resource variable into the four components, fuel, ores, agriculture and food.

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[25] The difference between home consumption and export may impact significantly on the empirical results. Whereas it is customary to proxy production with export figures, since the latter are often incomplete and unreliable, the differences between commodity groups may imply that the production of food and agricultural raw material is generally underestimated in a manner not unrelated to the stage of economic development. Assuming that a higher proportion of food production in lower income countries is for domestic consumption, relying on export statistics instead of production data would tend to overestimate the potentially negative impact of food on growth. Unfortunately, we are unable to avoid this potential bias as we have not been able to locate food production statistics.

On a similar note, a glance at external trade statistics should suffice to convince anyone of the tendency for the distribution of natural resources to be geographically concentrated. Radetzki (1990) points out that while total commodities are almost equally distributed between industrial and developing countries, ores are produced predominantly in industrial countries, whereas the opposite holds for fuels. To account for these structural differences, we substitute the natural resource variables by the residuals of a regression of the original commodity data on a set of regional dummy variables (Africa, Latin America, Mideast, Other non-industrial, and Industrial).

Table 6. The Growth Effects of Natural Resources 1/

	NatRes1	**NatRes2**	**NatRes3**	**NatRes4**	**NatRes5**	**NatRes6**
Corruption	0.79 ***	0.94 ***	0.92 ***	0.92 ***	0.98 ***	0.69 ***
Initial Income	-2.15 ***	-2.02 ***	-2.22 ***	-2.09 ***	-2.30 ***	-1.94 ***
Fuel_1970; Res_fuel70 2/	3.50	-1.39	-1.22	-1.54	...	...
Ores_1970; Res_ores70	-3.58 *	-2.80	-2.62	-3.13	...	...
Agriculture_1970; Res_agriculture70	3.34	2.36	0.85	2.48	...	...
Food_1970; Res_food70	-11.32 ***	-11.02 ***	-8.90 **	-9.18 **	-8.69 **	...
Fuel, ores and agriculture	...	...	...	...	-1.30	-1.51
Trade Openness	1.01	1.04 *	1.04 *	1.08 **	0.98 *	1.53 ***
Investment/GDP 3/	0.21	0.80	0.99 *	1.15 **	1.13 **	0.97 **
Terms of Trade	0.24 ***	0.34 ***	0.32 ***	0.31 ***	0.34 ***	0.31 ***
Commodity Price Variability in Africa	-0.09 ***	-0.09 ***	-0.07 ***	-0.07 ***	-0.08 ***	-0.06 ***
Commodity Price Variability in non-Africa	-0.03	-0.03	-0.03	-0.02	-0.03	-0.02
Government Consumption	...	...	-10.04 ***	-10.06 ***	-10.82 ***	-12.89 ***
Public Participation in Fuels	...	...	...	-0.29	...	...
Public Participation in Ores	...	...	...	0.56	...	...
Constant	17.81 ***	15.34 ***	17.82 ***	16.31 ***	18.35 ***	16.17 ***
Adjusted R-Sq.	**0.66**	**0.58**	**0.64**	**0.64**	**0.63**	**0.67**
No. Observations	**72**	**72**	**72**	**72**	**72**	**72**

1/ All regressions are estimated using 2SLS with 'Corruption' endogenized. Coefficients significant at the 1%, 5%, and 10% level of significance are indicated with ***, **, and *, respectively. A lower score on the corruption index indicates more corruption.

2/ NatRes1 includes the components of the original 'Natural Resources' (e.g. Fuel_1970) as independent variables. NatRes2-4 include the residuals from regressing each of the components of 'Natural Resources' (e.g. Res_fuel70) on a set of geographical dummy variables (Africa, Mideast, Latin America, Other Non-Industrial and Industrial). 'Fuel, ores and agriculture' in NatRes5-6 is the sum of Res_fuel70, Res_ores70 and Res_agriculture70.

3/ The investment ratio is instrumented with the relative price of investment goods in 1970 (log of the ratio of the investment deflator to the overall GDP deflator in 1970).

A resource boom has often triggered an (unsustainable) increase in government spending, an effect particularly important in cases of fuel or ore discovery and in developing countries, where the additional revenue mostly accrues directly to the government. To the extent that such spending spurts reflect current consumption instead of investment in economically justifiable projects, long-run economic growth should be negatively affected, partly in the likely event of a downturn in commodity markets. To account for this effect, we include, as an explanatory variable, the beginning-of-period ratio of government consumption to GDP, where government consumption is defined as government expenditure net of spending on defense and on education, and is originally taken from Sachs and Warner (1995a).

The results, as reported in Table 6 above, reveal that the negative effect of natural resources on growth is now confined to the food industry, with the conclusion robust to the inclusion of the variable on government consumption and to the aggregation of fuel, ores and agriculture into one variable. In NatRes6, the stability of the coefficients when food is omitted suggests that the negative effect of food is not an artifact of a high correlation with the remaining explanatory variables. Whether this result could be reversed by the use of data on food production instead of food exports, as discussed in footnote 25, remains an issue for further research.[26]

In the end, what do these results suggest about the effect of natural resources on growth? The next table calculates the total effect from previously estimated regressions. While the Sachs and Warner (1995a) results indicate that, on average, a one standard deviation increase in the ratio of natural resource exports to GNP is associated with a decrease of just over 1 percent in the growth rate, the results for our preferred specification, the equations previously labeled as Corr3 and NatRes3, indicate that the negative effect for fuel and ores is approximately half of that, at some 0.6 percent, and due entirely to the indirect effect through corruption. Meanwhile the effect for agriculture, owing to the latter's beneficial impact on corruption, is actually positive, whereas the effect for food remains negative.

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[26] One possible explanation for the negative impact of food production on growth is its relatively low productivity combined with high labor intensity and a confinement of production to rural areas. As a result, labor migration to urban areas, where it could engage in more productive activities, is impeded in the presence of mobility costs and consequently steady state output (and output growth during the transition period) reduced.

Table 7. One Standard Deviation Increase in Natural Resource Exports 1/

	Effect on Long-Run GDP Growth Rate 2/			
	SW4	LW2	NatRes1	NatRes3
Fuel	-1.15	-1.48	-0.53	-0.61
Ores	-1.15	-1.48	-1.10	-0.61
Agriculture	-1.15	-0.54	0.52	0.61
Food	-1.15	-0.54	-1.29	-0.82

1/ For SW4 and LW2, one standard deviation (of the aggregate measure 'Natural Resources') equals 16% of GNP. For NatRes1 and NatRes2, one standard deviation is 17% for 'Fuel', 9% for 'Ores', 3% for 'Agriculture' and 7% for 'Food'.

2/ LW2, NatRes1 and NatRes3 include the indirect effects of corruption as estimated by Corr3. Coefficients statistically insignificant at the 10 percent level were set to zero.

V. Conclusions

The present paper theoretically and empirically investigated a, thus far ignored, channel through which natural resources might affect a country's economic growth, i.e., through an increase in rent-seeking activities. More generally, the paper analyzed two inextricably intertwined broader issues. First, what factors determine the incidence of corruption, and in particular, what role does the abundance of natural resources play? Second, what factors affect economic growth, and how can one explain the stylized fact that resource rich economies tend to grow slower.

Given the scope of the paper, our analytical model focused on four major determinants of the extent of corruption: the corruption-dampening effects of improvements in monitoring technology and increases in penalties, and the corruption-fostering effects of capital-intensive production and concentration of bureaucratic power. In the framework of our model, natural resource discoveries were interpreted as technology shocks, with their extent depending on the specific type of commodity considered. Empirically, one of the main results was to confirm that capital intensive natural resources are a major determinant of corruption.

Other interesting features of the analytical model concerned the growth effects of (natural resource induced) corruption and anti-corruption policies. Whereas the existence of corruption always reduced growth compared to the non-corruption case, this negative effect exhibited some nonlinearities, being more pronounced in less developed economies (characterized by a lower initial steady-state capital stock). Correspondingly, the effectiveness of the two anticorruption policies considered also depended on the state of development of the economy. Institution building, i.e., improvements in monitoring technology, tends to be more effective in less developed countries, while stricter enforcement, i.e., increases in penalties, are predicted to be more effective in more developed countries. Empirically, the growth regressions unambiguously corroborate the negative growth effect of corruption and support our initial hypothesis of the corruption channel being an important explanation for the slow growth of resource-rich economies.

Both our theoretical and empirical results stress the importance of strong (or at least strengthened) institutions in the wake of natural resource discoveries as a way to curb the associated negative growth effects of corruption. This is especially true in less developed countries where natural resource discoveries have a much higher relative impact on both the capital stock and the extent of corruption, and are confronted with generally weaker and less adaptable institutions. Other interesting empirical results are the findings that, *ceteris paribus*, neither the corruption nor the growth process are different in Africa than elsewhere, and that rapid growth induces an increase in corruption.

This study constitutes a first step towards an investigation of the effect of natural resources on corruption and growth. In this context, it would be useful to model the government's anticorruption policies as the response of an optimizing agent, which would allow, *inter alia*, a formal derivation of the need for, and the extent of, institutional and administrative adjustments in response to resource discoveries. Empirically, production, instead of export, data for natural resources may help to explain the persistently negative coefficient of food items in the growth equation, and the addition of a time dimension to our empirical analysis would allow some understanding of the economic dynamics of natural resource discoveries.

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