Conflict Diamonds

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Abstract

'Conflict diamonds' refers to the fatal role that diamonds are believed to have played in several African conflicts. The article analyzes the impact of diamond abundance on economic growth in light of the broader, previously discovered empirical finding of a 'curse of natural resources'. By extending the theory of appropriative conflict, a predator-prey game is outlined in which a rebel chooses between peaceful production and predation on natural resources controlled by the ruler. It is shown that whereas an increase in natural resources will increase the ruler's public utility investments, it might also lead to a crowding-out of labor from the formal sector to the appropriative struggle, which depresses growth. As predicted by the model, a cross-country regression analysis suggests that diamond abundance has a negative relationship with economic growth in countries with weak institutions.

Keywords: diamonds, appropriative conflict, curse of natural resources, growth, predation.
JEL Codes: O13, O40, Q32

1 Introduction

Several empirical studies have indicated a negative relationship between natural resource abundance and economic growth (Sala-i-Martin, 1997; Sachs and Warner, 1997, 2001). The reasons for this 'curse of natural resources' are not well understood. In some cases, the curse seems to work through Dutch disease effects, i.e. the natural resource sector crowds out other sectors in society. In other cases, it appears that natural resource abundance gives

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rise to unproductive rent seeking that impedes economic development (Auty, 2001a). In general, there are good reasons to believe that the curse works very differently depending on the type of natural resource in question and on the nature of the economic environment. For instance, it has been argued that 'point resources' such as minerals have a particularly strong association with destabilizing social tension (Auty and Gelb, 2001).

This article focuses on a mineral resource that has received much attention in news reports during recent years for its alleged involvement as a prize in detrimental civil conflicts; *diamonds*. Fighting over diamond deposits are believed to have been an important reason for the initiation, maintenance and prolonging of civil unrest in Angola, Sierra Leone, Liberia, and the Democratic Republic of the Congo (henceforth referred to as Congo-Kinshasa). As a consequence, the United Nations have imposed sanctions on 'conflict diamonds' originating from areas controlled by illegitimate rebel groups (United Nations, 2002). Unconfirmed reports have also linked illicit diamond trade with terrorist organizations like Hezbollah and al-Qaeda (Farah, 2001a; 2001b; Hill, 2002; Campbell, 2004).

By extending the general appropriative conflict-framework of Grossman (1991), Hirshleifer (1991), and Grossman and Kim (1995), this article presents a model of the links between natural resource abundance, social conflict, and economic growth. The basic set-up is a sequential, predator-prey game between a ruler (the prey) in control of a flow of natural resource rents, and a rebel (the predator) who might choose to prey on the ruler's natural resource riches. Caught in between, there is a peaceful citizen who provides the country's official output and whose production depends on public utilities like roads provided by the ruler. The model shows that in equilibrium, an increase in natural resource rents increases ruler's public utility investments but also increases the ruler's need to defend himself against the predatory rebel. The need for defense forces might thus crowd out labor from the formal sector and depress growth. What effect dominates depends crucially on the strength of institutions constraining government expropriation and corruption. In countries with weak institutions, natural resources are likely to be a curse whereas the reverse is true in countries with strong institutions.

On the basis of the general model, it is argued that among all natural or mineral resources, diamonds are the ideal reward for a potential predator due to their extremely high price, their efficient convertibility to money or arms, their small practical size, their indestructibility, and the difficulty with which their origin can be established. In an empirical section, it is further shown that a 'Barro-style' cross-country growth regression provides some support for the basic hypothesis of a negative relationship between diamond abundance and growth for the sample of predominantly weakly institutionalized diamond producers.

The article is related to and attempts to synthesize two distinct lines of research. The first line of research is that dealing with the relationship between natural resource abundance and economic development. Empirically, the curse of natural resources on growth has been explored primarily by Jeffrey Sachs and Andrew Warner (1997, 2001), although earlier studies have recognized the potentially negative effects of a great resource endowment on development in general (for overviews, see Sachs and Warner, 1997 or Auty, 2001). Several explanations have been proposed in the literature. The Dutch disease explanation - originally formalized by Corden and Neary (1982) and supported by Sachs and Warner (1997, 2001) - suggests that a booming resource sector leads to an exchange rate appreciation that crowds out exports from the important manufacturing sector, which in the longer run is the key sector of the economy. Another hypothesis is that an abundance of natural resources make governments neglect investments in human capital (Gylfason, 2001). Mehlum et al (2002) and Boschini et al (2003) further show empirically that the prevalence of a resource curse depends critically on the quality of institutions.

Proponents of the political economy view argue that a great resource abundance typically leads to a factional, predatory state (as opposed to a developmental political state) that is characterized by soft market constraints, a small, privileged elite in control of the resources, slow human and social capital accumulation, and the retarded emergence of a manufacturing sector (Lal and Myint, 1996; Auty, 2001b; Auty and Gelb, 2001). This so called 'staple trap model' provides a general, intuitive framework for understanding how causality runs from resource endowments to poor economic outcomes. But due to its schematic simplicity, it cannot be easily used for a more formal analysis of marginal effects or empirical model calibrations. A more rigorous analysis of the relevant links has recently been provided by Torvik (2002) whose model shows that an increase in natural resources increases the number of entrepreneurs engaged in rent seeking and hence decreases income.

The second research tradition is the economics of social conflict which is more in line with mainstream economic theory (Tullock, 1974; Roemer, 1985; Grossman, 1991; Hirshleifer, 1991, 1995; Skaperdas, 1992; Grossman and Kim, 1995; Noh, 2002; Mehlum et al, 2003). The typical set-up is an economy where private property rights are not perfect so that a one-shot or sequential game arises where agents might choose between normal productive activities and predation on the other agent's assets. The two agents might be either a predator and a prey or two opposing factions. In their empirical assessments of the determinants of civil war during 1960-99, Collier and Hoeffler (1998, 2001) shows that economic agendas (greed) are indeed often the driving force in social conflict, as predicted by theory. Similar results for the post-Cold War era have been obtained by de Soysa (2002). So far, conflict theory has not often been used in more empirically oriented analyses of economic development. Collier (2000a) is one of few attempts that use this theory to analyze the relationship between natural resource abundance and social unrest, but linkages to growth are not derived.

The research presented below makes at least two contributions to the existing literature: First, the article presents a comprehensive theory of the links between natural resource abundance, social conflict, and economic growth. In doing so, it synthesizes the theoretical literature on social conflict with the empirical findings of a curse of natural resources conditional upon the quality of institutions. Second, to the author's knowledge, it is the first effort to make an empirical analysis of the rough diamond industry in the light of conflict theory and to assess econometrically the relationship between diamond production and growth for a large sample of countries.

The article is structured as follows: Section two gives a brief overview of the basic facts about the rough diamond industry. Section three presents a model of appropriative conflict while section four argues that among all natural resources, diamonds are the ideal reward for a loot-seeking rebel. Section five then provides the empirical analysis. Section six concludes the exposition.

2 The Rough Diamond Industry

Total annual production of rough diamond in the world today amounts to about 120 million carats (or 24 tons). Table 1 lists the current 18 diamond producing countries in the world. Australia has had the highest average annual production during the 1990s at 39 million carats, followed by Russia, Congo-Kinshasa, Botswana, and South Africa. These five countries alone had roughly 88% of total world production. Africa is by far the continent with the greatest number of diamond-producing countries (12 of 18).

Depending on quality, rough diamonds can be used either as gemstones or for industrial purposes. Stones with the highest quality in terms of clarity and color are sold at high prices as gemstones at major diamond trading centres such as Antwerp, Dubai, New York or Tel Aviv. They are then reexported all around the world to be cut and polished. Once a diamond has come this far in the process, its origin is impossible to trace. As Table 1 shows, the percentage of gemstone in total production varies from 20% in China to almost 95% in Namibia and 100% in Canada. The gemstone percentage gives an indication of the value of production. The average price per carat in the year 2000 of a diamond from Namibia amounted to 271$ as compared to the average world price of 71$ (Rombouts, 2001).

If average annual production is divided by land area, we get an indication of the intensity of diamond abundance in the individual countries. The third column in Table 1 shows that the dominant country in this comparison is Botswana with a production of nearly 31 carats per square kilometer. Second and third, but far behind, comes Congo-Kinshasa and South Africa at 8.4 and 8.2. Note that some very small countries like Sierra Leone become relatively diamond intensive (3.84) whereas the second greatest producer in absolute terms, Russia, now receives a low intensity (1.2).

The term *conflict diamonds* or *blood diamonds* alludes to the role that diamonds have played in initiating, financing, and possibly prolonging civil wars in Africa. The United Nations use the following definition: "Conflict diamonds are diamonds that originate from areas controlled by forces or factions opposed to legitimate and internationally recognized governments, and are used to fund military action in opposition to those governments, or in contravention of the decisions of the Security Council." (United Nations, 2002).

Fighting over diamonds is not a new phenomenon. Already in the Medieval times, diamonds were the cause of war among Indian kingdoms. However, the link between diamonds and civil war was highlighted in the end of the 1990s when it became apparent that the Angolan rebel army UNITA could sustain its long war against the government with the assistance of proceeds from diamond exports. In an effort to reduce fighting, the UN Security Council adopted resolutions 1173 and 1176 that prohibited direct or indirect import of all Angolan diamonds that were not certified by the government. Diamonds were also found to be a prime source of revenue for the RUF rebel movement in Sierra Leone, infamous around the world for their atrocities against civilians. In the year 2000, the Security Council's resolution 1306 imposed a ban on all import of diamonds supplied by the RUF. Due to the Liberian government's links to the RUF, a ban on imports from that country was adopted the following year (United Nations, 2002). Panel of Experts (2001a, 2001b) have further revealed how diamonds and other natural resources in Congo-Kinshasa have played a crucial role in the continuing international conflict on Congolese soil that followed the uprising against president Laurent Kabila.

It should be remarked though that by winter 2004, a development towards peace was in place in at least Congo-Kinshasa, Angola, and Sierra Leone, although the first country sporadically experiences intense ethnic warfare in the Ituri region. The direction of development in Liberia, where warlord president Charles Taylor was overthrown by rebels, is still unclear.

The fourth column of Table 1 gives a feeling for the disastrous economic effects of diamond-related wars in the 1990s. The average annual growth rate between 1990 and 1999 was -3.14 percent in Angola, -7.86 in Sierra Leone, and -8.33 in Congo-Kinshasa. In real terms, income per capita during the period declined by almost 50 percent in the latter country.

3 Theory

In the subsection below, we will present a model of a developing economy where a potential predatory rebel is motivated by the prospect of conquering the rents from a natural resource endowment that is initially controlled by a ruler. The model suggests a mechanism through which natural resource abundance might cause appropriative conflicts that are harmful to growth.

3.1 A Predator-Prey Model

The model assumes an economy with three representative agents; a ruler whom we will refer to as *Ruler*, a prospective rebel called *Rebel,* and a common man called *Citizen.* These three agents might be thought of as representing different social classes or ethnic groups in society. The interaction between the three takes the form of a sequential game where Ruler is a Stackelberg leader who makes his allocative choices first. We will analyze developments over two periods; an initial peaceful period and a second period that might or might not be characterized by social conflict. The two stages of the game are both played out in the second period. One time period should be thought of as a decade.

Rebel does not take part in the formal economy. Normally, he lives on subsistence activities but might also resort to predation on Ruler's natural resources. He might or might not reside in the country whose ruler he occasionally attacks. Rebel might be marginalized from the rest of the economy because of ethnic discrimination or just because the formal sector is too small to swallow all rural people.[1]

Let us assume that Rebel controls a labor endowment l which represents the value of his total labor effort during one period. In the first period, Rebel is peaceful and lives on subsistence. In the second period, Rebel considers splitting his total effort between productive activities q_2 and predatory activities a_2 such that $l = a_2 + q_2$. Predatory activities are meant to include both relatively non-violent extortion as well as armed rebellions. The object of predation is Ruler's appropriable natural resource endowment D. This variable shows the world market value of natural resource extraction during a period of time (we normalize the price to be equal to 1). For simplicity, we assume that the flow of natural resource rents is identical in the two periods.

Rebel's utility function is:

$$U_{Rebel} = \eta l + \eta (l - a_2) + p_2 \delta D \tag{1}$$

The level of utility U_{Rebel} thus depends on first and second-period subsistence production (the first two terms on the right-hand side) and on revenues from natural resource predation (the last term). The incomes from predation and production are perfect substitutes and Rebel's sole source of utility is his own material well-being.[2]

Starting with the revenues of predation, p_2 is the fraction of appropriable natural resources D that Rebel manages to conquer in the struggle with Ruler in the second period and $(1 - p_2)$ is the fraction that Ruler retains. The determinants of p_2 will be discussed below.

As a result of the known hostility between Ruler and Rebel, the natural resources of the country must be offered abroad at a discounted price in the second period, reflected by the parameter $\delta < 1$. This discount will be in place regardless of whether an actual war breaks out or not. The level of the discount depends on the publicity that the conflict receives abroad

[1] There are several instances of peoples being deliberately marginalized for ethnical reasons. One such group are the Banyamulenge in former Zaire who lost their citizenship during Mobutu's last years and then took part in the rebellion led by Kabila (Olsson and Congdon Fors, 2004).

[2] What this implies is that when Rebel considers starting a predatory rebellion, he is completely indifferent about matters such as justice, honor, or prestige. For the realism of such an assumption, see the discussions in Herbst (2000) or Collier and Hoeffler (2001).

and from foreign traders' assessment of the risks of buying natural resources from the country in question. It might even be the case that sanctions are imposed, which would make δ low or even zero in the case of a perfect sanction. However, if it is hard to trace the origin of D and if the natural resource is easily smuggled, then δ will tend to be closer to the world market price. The 'post-conflict' value of the appropriable, extracted resources is therefore δD and the effective utility from Rebel's conquest is $p_2 \delta D$.

Output from peaceful subsistence is given by the extremely simple 'AK'-production function ηq_t where η is a productivity parameter and where $q_1 = l$ and $q_2 = (l - a_2)$. Obviously, peaceful production is the opportunity cost of predation.

The share of natural resources that Rebel conquers is given by a function describing the 'technology of conflict':[3]

$$p_2 = \frac{a_2}{a_2 + b_2} \tag{2}$$

As mentioned above, a_2 is the labor that Rebel devotes to predation whereas the new variable b_2 reflects labor resources that Ruler devotes to defending his natural resource endowment D. These labor resource are provided by Citizen, who must follow Ruler's orders. At any level $b_2 > 0$, an increase in Rebel's predation effort a_2 increases the fraction that Rebel captures and vice versa. More precisely, it is easily shown that p_2 is positive and concave in a_2 and negative and convex in b_2. $a_2 + b_2$ is the total number of people in society allocated to appropriative conflict.

Citizen stands for the country's total formal production which includes sectors like manufacturing, modern agriculture, and formal services. In our model, Rebel does not prey on Citizen since the formal sector's output is not as easily appropriated as a stock of valuable natural resources.[4] The level of output is given by a standard Cobb-Douglas production function

$$y_t = A h_t^{\alpha} k_t^{1-\alpha}. \tag{3}$$

A is a total factor productivity, capturing aspects like the level of technology, environmental factors, or the general quality of government policy and institutions in the country's formal sector. h_t is the labor that citizen devotes to formal production at time $t = (1, 2)$ whereas k_t is the stock of physical public utilities like roads, electricity, and water provided by Ruler. Note that unlike Rebel, Citizen can fully utilize k_t. In both periods, Citizen has a total labor endowment of n. This endowment is split between productive activities h_t and defense against the predatory Rebel b_t such that $n = h_t + b_t$. Since the first period is peaceful, $h_1 = n$ whereas we might have that $h_2 = n - b_2$. Ruler decides what level of b_2 that is required, as will be shown below.

[3] See for instance Hirshleifer (1989), Grossman (1991), or Neary (1997) for discussions of the properties of different forms of this function.

[4] Actually, there are several instances of how rebels have resorted to looting the local population rather than fighting the government army (Azam, 2002). In order to keep the model simple, we will not consider this possibility in the model.

For his labor services in the formal sector, Citizen receives a wage equal to the his marginal product. The total wage payment is therefore $\alpha A h_t^{\alpha} k_t^{1-\alpha}$. Ruler taxes Citizen with a marginal income tax rate of $\tau < 1$. This tax rate should be thought of as the revenue-maximizing tax rate in line with a Laffer curve-like framework. Ruler does not attempt to tax Rebel who is hiding in the bush. We assume that Citizen's after-tax income is always higher than Rebel's maximum income from peaceful work: $(1-\tau)\,\alpha y_t > \eta l$. If it were not, Citizen would have an incentive to take up subsistence agriculture in the jungle and become an outlaw rebel.[5] Citizen's objective is simply to retain as much income as possible after taxation.

In each period t, Ruler thus controls two types of income streams; the tax payments from Citizen and the proceeds from selling one period's extraction of natural resources on the world market D. We assume that tax payments finance short-run state administration G such that $\tau\alpha y_1 = G$. Natural resource rents D are either used for more long-term investments in public utilities $(k_{t+1} - k_t)$ or for personal enrichment of the Ruler and his cronies. Let $\gamma(Z) \in [0,1]$ be the fraction of total rents that is used for productive ends. This fraction depends positively on the quality of property rights institutions Z, reflecting the constraints against government expropriation. The essential properties of the function are $\gamma'(Z) > 0$, $\lim_{Z\to\infty} \gamma(Z) = 1$, and $\lim_{A\to 0} \gamma(Z) = 0$. The fraction $1-\gamma(Z)$ is withdrawn from the formal economy into the Ruler's pockets.[6]

Since k_1 is given from previous periods, Ruler faces the budget restriction:[7]

$$\gamma(Z)\,D = (k_2 - k_1) \tag{4}$$

Finally, we assume that Ruler's utility is a simple additive function of government revenue over the two periods:

$$U_{Ruler} = D + \tau\alpha y_1 + (1-p_2)\,\delta D + \tau\alpha y_2$$

Large government revenues means great power and good opportunities for personal enrichment, as was discussed above. If there is a battle against Rebel in the second period, Ruler rescues a share $(1-p_2)\,\delta$ of his natural resource wealth where p_2 was defined above. Note that Ruler only indirectly (via tax receipts) receives utility from the levels of national output y_t.

[5] Rewriting the relation between Peasant's and Rebel's peaceful incomes yields the condition that Peasant will stay at his fields as long as $\tau < 1 - \frac{\eta l}{\alpha y_t}$.

[6] Ndikumana and Boyce (1998) describe how the enrichment strategies of Zaire's dictator Mobutu (who probably had a $\gamma(Z)$ close to 0) included direct transfer of enormous proceeds from natural resource exports to presidential accounts. See also Bigsten and Moene (1996) for an analysis of various forms of rent diversion in Kenya and Congdon Fors and Olsson (2004) for a model where institutions constraining expropriation are endogenously determined.

[7] We could have included tax revenue as a component of the budget constraint below, but that would have made the model more complicated without adding anything to the key line of argument that natural resource rents potentially increase the stock of public goods.

3.2 Equilibrium

Let us assume that after a peaceful first period, Ruler and Rebel allocate their second period resources in a two-stage, sequential game. Ruler, who might be regarded as a Stackelberg leader, moves first and decides on how much of Citizen's labor he needs in order defend his natural resources (b_2), taking into account the likely response from Rebel in terms of levels of predation (a_2).[8] In the second stage, the predatory Rebel makes his actual move and takes Ruler's choice as given.

In order to find the subgame perfect equilibrium, we use backward induction and start our analysis in the second stage when Rebel chooses the levels of a_2 and q_2 that maximize his utility function. By inserting (2) into (1), we can define the optimization problem:

$$\max_{a} \frac{a_2 \delta D}{a_2 + b_2} + \eta \left(l - a_2 \right) \tag{5}$$

The first-order conditions for this problem are:

$$\frac{\partial U_{Rebel}}{\partial a_2^*} = \frac{\delta D}{a_2^* + b_2} - \frac{a_2^* \delta D}{\left(a_2^* + b_2 \right)^2} - \eta : \begin{matrix} \leq 0, & a_2^* = 0 \\ = 0, & a_2^* > 0 \end{matrix} \tag{6}$$

The upper case describes a scenario where no interior local maximum exists. This implies that the opportunity cost of predation is too high and that Rebel optimally chooses to allocate all effort to production ($q_2 = l$).

The lower row in (6) defines an interior solution where the optimal a^* is a quadratic function that turns out to have two roots; one positive and one negative. Disregarding the negative one, we can establish the reaction function and the optimal (positive) level of predatory effort:

$$a_2^* = \sqrt{\frac{b_2 \delta D}{\eta}} - b_2 \tag{7}$$

(7) defines all responses that Rebel makes to a given level of Ruler's chosen defense level b_2.[9] Simple calculus shows that a_2^* is a positive or negative, concave function of b_2, as shown in Figure 1. At low levels of b_2, an increase in Ruler's strength increases Rebel's predatory efforts whereas beyond a certain level, Rebel's predatory effort decreases with b_2. No predatory activity at all will take place ($a_2^* = 0$) if

$$b_2 \geq \frac{\delta D}{\eta}. \tag{8}$$

Analogously, Rebel will only initiate a conflict ($a_2^* > 0$) if $b_2 \in \left(0, \frac{\delta D}{\eta} \right)$. We will use this result below.

[8] Models of appropriative conflict often take the form of a Cournot game (Hirshleifer, 1991, 1995). However, in the type of predator-prey model described here, it seems more appropriate to to think of the situation as a two-stage game where the prey moves first.

[9] We assume that we can rule out the existence of upper boundary solutions where $a_2^* = l$.

When we have thus derived Rebel's reaction function, we can go back to the first stage and insert this expression into Ruler's utility function. Ruler's maximization problem then becomes

$$\max_{b_2} \; c + \sqrt{b_2 \delta \eta D} + \tau A \left(n - b_2\right)^{\alpha} k_2^{1-\alpha}. \tag{9}$$

where $c = D + \tau \alpha y_1$ is independent of b_2. Taking the first-order condition for maximum, we have that the equilibrium level of defense effort is implicitly defined by

$$\frac{\sqrt{\delta \eta D}}{2\sqrt{b_2^*}} - \tau \alpha^2 A \left(\frac{k_2}{(n - b_2^*)} \right)^{1-\alpha} = 0. \tag{10}$$

This expression does not allow for an explicit solution for b_2^*. However, it is still useful for deriving comparative statics results.

3.3 Comparative Statics

Straightforward implicit differentiation on (10) shows for instance that b_2^* increases with appropriable natural resource rents δD and with the total size of formal sector labor n, and decreases with formal sector productivity A for all $\alpha \in (0, 1)$. Without loss of generality, we might therefore make the assumption that $\alpha = 1/2$, which allows us to define an explicit solution to b_2^*:

Lemma 1 *If it is assumed that $\alpha = 1/2$, then the equilibrium level of defense effort will be*

$$b_2^* = \frac{n}{1 + \frac{(\tau A)^2 (k_1 + \gamma(Z) D)}{4 \eta \delta D}}. \tag{11}$$

This level constitutes a conflict equilibrium where $a_2^* > 0$ if and only if $\delta D + \frac{(\tau A)^2 (k_1 + \gamma(Z) D)}{4\eta} - n\eta > 0$.

Proof. The expression in (11) is easily obtained from the first-order condition in (10), given that $\alpha = 1/2$. We further insert $k_2 = k_1 + \gamma(Z)$ from the budget constraint in (4). As was stated in (8), we will have a conflict equilibrium with $a_2^* > 0$ if $b_2^* < \frac{\delta D}{\eta}$. By manipulating this inequality, we get the result that $\delta D + \frac{(\tau A)^2 (k_1 + \gamma(Z) D)}{4\eta} - n\eta > 0$ ■

As in the general case, the Lemma shows that b_2^* increases with appropriable natural resource rents D and with the size of formal sector labor n, and decreases with formal sector productivity A and with the quality of property rights institutions Z. The second result in Lemma 1 might be summarized by saying that a conflict equilibrium where both Rebel and Ruler allocate resources to an appropriative struggle is more likely the greater is D, A and Z, and the smaller is n.[10] For the sake of concreteness, we will assume that Lemma 1 applies in the derivations below.

[10] See Olsson and Congdon Fors (2004) for a more detailed analysis of the 'trigger factors' that need to be in place for a conflict equilibrium to occur.

The equilibrium share of appropriable natural resources that Rebel manages to conquer from Ruler in the second period is

$$p_2^* = \frac{a_2^*}{a_2^* + b_2^*} = 1 - \sqrt{\frac{n\eta}{\left(\delta D + \frac{(\tau A)^2 (k_1 + \gamma(Z) D)}{4\eta}\right)}}. \tag{12}$$

Rebel's success (and Ruler's corresponding level of failure) is thus mainly a function of natural resource abundance, productivity, institutions, and the absolute size of the formal sector:

Proposition 2 *The equilibrium share of appropriable resources that Rebel conquers increases with δ, D, A, and Z and decreases with n and η.*

Proof. The results follow from straightforward differentiation. ■

The expression in (12) describes the realized success of a predatory rebel group.[11] Rebel's success is positively related to the productivity in the formal sector A, with institutions against corruption Z and with the tax rate τ. High levels of A, Z, and τ mean that Ruler's marginal utility of having Citizen work in the formal sector is high which makes b_2^* relatively low and thus p_2^* high. A high productivity in Rebel's subsistence production η implies that his opportunity cost of predation is high, which lowers the equilibrium share of conquered resources.

The direct production shortfalls in the formal sector as a result of the appropriative struggle is

$$A\sqrt{b_2^* \cdot k_2} = A\sqrt{\frac{n\left(k_1 + \gamma\left(Z\right)\right)}{1 + \frac{(\tau A)^2 (k_1 + \gamma(A) D)}{4\eta\delta D}}}.$$

This result might be summarized in a Proposition:

Proposition 3 *The production shortfall in the formal sector due to the appropriative conflict increases with δ, D, and η, n and A. .*

Proof. The results follow from straightforward differentiation. ■

Lastly, and most importantly, we will make some comparative statics on the growth of formal output. From (3), we know Citizen's formal sector output, which is identical to total aggregate output in the economy. The growth rate over the two relevant periods is approximately equal to

$$\begin{aligned} g = \ln y_2 - \ln y_1 &= \frac{1}{2}\left(\ln\left(\frac{n - b_2^*\left(D\right)}{n}\right) + \ln\left(\frac{k_2\left(D\right)}{k_1}\right)\right) \\ &= \frac{1}{2}\left(\ln\left(1 - \frac{1}{1 + \frac{(\tau A)^2 (k_1 + \gamma(Z) D)}{4\eta\delta D}}\right) + \ln\left(\frac{k_1 + \gamma\left(Z\right) \cdot D}{k_1}\right)\right) \end{aligned} \tag{13}$$

[11] For instance, it might be thought of as explaining the share of total natural resources that rebel groups like the RUF in Sierra Leone had managed to lay their hands on after years of conflict.

This reduced-form expression shows one of the basic intuitions behind the model; whereas natural resource abundance crowds out labor from the formal sector through its positive impact on b_2^* (which is bad for growth), it will also induce greater investments in public utilities (which is beneficial for growth). Whether natural resources are a curse or a blessing will depend on the relative strength of the two effects. On an elementary level, it is clear that if there are no potential rebels so that a_2^* and b_2^* are zero, natural resources will be positive for growth. On the other hand, if Ruler must allocate a substantial force to defend his rents and if institutions are so poor that $\gamma(Z)$ is close to zero so that almost all proceeds vanish in various forms of corruption, then an abundance of natural resources will be detrimental to growth.

More formally, we can derive :

Proposition 4 *(i) The equilibrium growth rate of aggregate output increases with A and Z, decreases with η and δ, and decreases (increases) with D if $\frac{(b_2^*)'}{\gamma(Z)} > \frac{h_2}{k_2}$ $\left(\frac{(b_2^*)'}{\gamma(Z)} < \frac{h_2}{k_2}\right)$. (ii) The marginal effect of D on the growth rate increases with the quality of institutions Z.*

Proof. (i) The results regarding A, Z, η, and δ are straightforward. The first derivative of the growth rate with respect to natural resource abundance yields: $\frac{\partial g}{\partial D} = -\frac{(b_2^*)'}{2(n-b_2^*)} + \frac{\gamma(Z)}{2(k_1+\gamma(Z))}$. Recalling that $n - b_2^* = h_2$ and that $k_2 = (k_1 + \gamma(Z))$, we can easily rearrange and get the result.

(ii) What we need to establish in the sign of $\frac{\partial^2 g}{\partial D \partial Z} = -\frac{\partial\left((b_2^*)'\right)}{\partial Z}\frac{1}{2(n-b_2^*)} - \frac{(b_2^*)'}{2(n-b_2^*)^2}\frac{\partial b_2^*}{\partial Z} + \frac{\gamma'(Z)}{2\left(\frac{k_1}{\gamma(Z)}+1\right)^2}\frac{k_1}{\gamma(Z)^2}$. The last term is clearly positive. We further know from Lemma 1 that $\frac{\partial b_2^*}{\partial Z} < 0$. The derivative of b_2^* with respect to D is $(b_2^*)' = \frac{b_2}{\left(1+\frac{(\tau A)^2(k_1+\gamma(Z)D)}{4\eta\delta D}\right)} \cdot \frac{(\tau A)^2 k_1}{4\eta\delta D^2}$. Visual inspection assures us that $\frac{\partial\left((b_2^*)'\right)}{\partial Z} < 0$. Hence, it must be the case that $\frac{\partial^2 g}{\partial D \partial Z} > 0$. ■

A high formal sector productivity A decreases b_2^* and thus increases the growth rate. In a similar manner, a high quality of property rights institutions Z decreases b_2^* and increases k_2. Rebel's subsistence productivity η is negatively related to predatory activity a_2 which means that if η is large so that a_2 is small, the marginal utility of allocating labor to defense is great, implying a high b_2^* and a low growth rate. The logic for δ is simply that if the price fall in the second period is substantial so that δ is small, there will be small rents to fight for, which will mean a low b_2^* and high growth.

The central result of the proposition concerns D. The condition that growth will decline with D if $(b_2^*)'/\gamma(Z) > h_2/k_2$ means that there will be a curse of natural resources if the relative marginal effect of D on defense forces (on the left-hand side) is larger than the inverted capital/labor ratio in the formal sector (on the right-hand side). What this means is that if the formal sector at the time of the struggle is relatively labor intensive - perhaps because it is dominated by modern agriculture - then the marginal product of labor will be relatively small. A loss of labor to the appropriative struggle is therefore less harmful to growth than in the case of a capital intensive manufacturing sector where the marginal product of labor is high.

The expression also makes clear the crucial role of the "corruption function" $\gamma(Z)$. As stated in (ii) in the Proposition above, the effect of natural resource abundance on growth will depend on the institutions constraining government expropriation and corruption. Should $\gamma(Z)$ approach zero, then $\frac{\partial g}{\partial D} < 0$, whereas it is quite possible that $\frac{\partial g}{\partial D} > 0$ if $\gamma(Z)$ approaches unity. This confirms the basic conclusion in some recent empirical articles that the presence of a curse of natural resources will depend to a great extent on the quality of institutions (Boschini et al, 2003; Mehlum et al, 2002).

4 Diamonds Are A Rebel's Best Friend

Several different kinds of natural resources have served as rewards for rebellions and as sources of revenue to dictators (see for instance Collier, 2000b or Olsson and Congdon Fors, 2004). The argument made in this section is that among all natural resources, diamonds are the ideal reward for a predatory rebel, in other words one that ensures exceptionally high levels of D, γ, and δ. The reason why this is the case can be summarized by two terms; *appropriability* and *tradability*. Starting with appropriability, this term reflects the characteristic that it is actually possible to gain physical control and make economic use of whatever D represents. 'Point resources' such as mineral deposits are readily appropriable since they are immobile while it is much more complicated to gain control of, for instance, a herd of elephants. Plantations and fields of corn are also immobile, but when an enemy approaches, it is easy for a retreating army to burn fields or destroy harvested crops. Even oil fields can be destroyed by a retreating army, as the Iraqis showed in the Gulf War. In the terminology of our model, these resources therefore have a relatively low appropriability. A mine with ore imbedded in rock, on the other hand, is not easily destroyed. Furthermore, once diamonds have been extracted, they are a reliable long-term store of value, unlike timber or crops.

Apart from being readily appropriable, diamonds are also highly tradable. This term encompasses several characteristics. To begin with, diamonds' most obvious advantage is their high average price per carat. Diamond prices vary significantly depending on clarity and color and whether they are sold as gemstones or as industrial diamonds. Rough diamonds are therefore far from a homogeneous good. In the year 2000, the average world market price per carat was 71$ (Rombouts, 2001), which is roughly equivalent to 355,000$ per kg. To make a comparison, the price for gold in 2000 was roughly 9,000$ per kg (or 280$ per troy ounce (US Geological Survey, 2001, *Gold*, Table 1)), i.e. the price of diamonds was on average about 40 times higher than that of gold. Needless to say, prices of metals like silver, copper, or iron are even lower. But not only is the price of diamonds very high, it has also been kept relatively stable over time due to the market power enjoyed by the dominating company DeBeers.

Tradability is also intended to reflect the transaction costs involved in the exchange of a commodity for money or for other goods. In comparison to for instance oil and timber, the transportation of diamonds is easy and cheap. Traders can carry anything from a single stone to a whole wagonload. Even for being a gemstone, this flexible practical size is unusual (US Geological Survey, 2001, *Gemstones*, Table 1). Unlike drugs like cocaine, which might also be illegally carried in very small amounts, dogs in a customs office can not sniff diamonds, nor will the stones be disclosed by metal detectors.

Once polished, it is almost impossible to determine a diamond's place of origin. This circumstance makes the imposition of sanctions (in other words, lowering δ) a complicated issue. In order to make the UN sanctions against the exportation of conflict diamonds more efficient, some thirty governments involved in the so called 'Kimberley Process' agreed in late 2001 to introduce and honour a certificate of origin scheme (Diamond High Council, 2001). However, so far, the mainly artisanal, small-scale production in Central Africa, in combination with porous country borders, mean that conflict diamonds from Sierra Leone, Angola, Liberia and Congo-Kinshasa easily slip into neighboring countries that are not under sanctions like Uganda, Central African Republic and Congo-Brazzaville, whereupon they are re-exported to the major trading centers in Belgium, the Netherlands, and Israel (Panel of Experts, 2001b). According to some sources, the smuggling is often carried out by foreigners with links to terrorist organizations like Hezbollah and al-Qaeda (Farah, 2001b).

5 Empirical Evidence

5.1 Model Specification

The model above predicts that the growth rate of output per capita will be a negative function of natural resource rents D in countries where institutions are weak. The chain of causality runs from resource incomes D to Ruler's optimal level of defense forces b_2^* that crowd out labor from the formal sector and reduce growth. Unlike in Collier and Hoeffler (1998, 2001), the key dependent variable in our setup is not social conflict but economic growth, although Table 1 clearly suggests a strong empirical relationship between diamond abundance and social conflict. We will thus follow the reduced form equilibrium growth expression in (13) and regress growth directly on D. The latter variable will henceforth be a measure of rents from diamond extraction. Table 1 also indicates that almost all diamond producing countries (the exceptions being Canada and Australia) are developing countries with relatively weak institutions. We therefore expect a basic negative relationship between diamond abundance and growth. We will also use a measure of institutional quality as a proxy for Z. The other possible sources of influence, like A, δ, and τ will be regarded as structural parameters which are not quantitatively assessed in this section.

More specifically, the cross-country growth regression that is tested below is of the typical 'Barro-style':

$$\mathbf{g} = \boldsymbol{\alpha} + \boldsymbol{\beta}\mathbf{X} + \boldsymbol{\phi}\mathbf{K} + \boldsymbol{\varepsilon} \tag{14}$$

In this set-up, $\mathbf{g}$ is a $N \times 1$ vector of economic growth rates, $\boldsymbol{\alpha}$ is a constant, $\mathbf{X}$ is a $N \times c$ matrix of control variables with a vector of estimates $\boldsymbol{\beta}$, $\mathbf{K}$ is a $N \times d$ matrix of variables derived from the theoretical section above, $\boldsymbol{\phi}$ is its vector of estimates and $\boldsymbol{\varepsilon} \sim N(0, \upsilon^2)$ contains the normally distributed error terms. The key variables for this article are of course those included in $\mathbf{K}$, that is primarily diamond rents but also institutional quality. Different specifications of $\mathbf{K}$ will be used depending on what the regression is intended to test. The basic hypothesis is that there should be a negative relationship between growth and diamond rents D in the sample at hand. $\mathbf{X}$ is a set of control variables that follow from standard growth accounting (see for instance Sala-i-Martin, 1997).[12]

5.2 Data

The empirical section presents a cross-country regression analysis using a sample of 131 countries that in 1999 had a population of more than 1 million and for which there was available data on growth rates. The period analyzed is 1990-99, i.e. the Post-Cold War era. There are two reasons for this choice of time period: First, the arrival of the Post-Cold War era brought a new economic regime to the world that was in many ways structurally different from the previous one. Studying growth patterns during this period is interesting in itself. Second, it is frequently claimed in the literature that the post-Cold War era initiated a greater strategic interest in natural resources. With the end of financing from the US and the Soviet bloc, rebel and terrorist movements around the world often had to reorganize their financing activities towards natural resource exploitation (Klare, 2001).

The effect of diamond abundance on growth is the central issue in the empirical section. In their important empirical studies on natural resources and growth, Sachs and Warner (1997, 2001) use the ratio of primary product exports to GDP as the explanatory variable and refer to it as a measure of natural resource abundance. In a similar fashion, we have constructed a variable *DiaGDP* that estimates the value of diamond production in each country as a share of GDP. Unfortunately, it was not possible to estimate the value of production in the starting year, 1990. Instead, the average price of diamonds in each country in the year 2000 was used (Rombouts, 2001) and was multiplied by production quantity for 1999 (US Geological Survey, 2001). This estimated value of diamond production was then divided by total real

[12] As discussed by Temple (1999), there are a number of potential problems with this simple approach such as multicollinearity, parameter heterogeneity, and the impact of outliers. These problems will be addressed below. We chose nevertheless to use this type of framework in order to make our results comparable to previous studies in this tradition.

GDP in 1999 (latest available year). The resulting variable DiaGDP serves as a proxy for the intensity of diamond production in a country. Due to relatively stable prices and production, this level is not likely to have changed much during the 1990s. Only 18 countries produce any diamond and all remaining countries therefore score zero.

However, the value of diamond production as a share of GDP for a single year is not really a proper measure of diamond *abundance*. Given two countries with identical levels of diamond extraction, the country which has the somewhat higher GDP is automatically also less diamond abundant according to this measure. Hence, DiaGDP is partly an endogenous variable that might also be correlated with the control variables in $\mathbf{X}$, a problem which is not adequately discussed in Sachs and Warner (1997) who uses a similar measure. In order to find a more accurate measure of abundance, we calculated the average annual production during 1990-99 in the 18 countries that produced diamonds in 1999 (US Geological Survey, various issues). Taking the mean removes possible cyclical aspects of production. In order to compare meaningfully diamond abundance in vast countries like Russia with that in small ones like Sierra Leone, we divided total production by land area to create the variable *DiaArea*. The (extreme) outlier is Botswana with roughly 31 carats per sq km with Congo-Kinshasa second at 8.41 carats.

As a third indicator of diamond rents, we assessed the value of total production in the year 2000 and divided this figure with land area to get production value in hundreds of US dollars per sq km. The resulting variable is referred to as *DiVaAr.* Unlike DiaGDP, and many other indicators of natural resource rents or abundance used in the empirical literature, DiaArea and DiVaAr have the advantage of being truly exogenous.

The other key determinant of appropriative conflict and growth is productivity in the formal sector. Productivity depends to a great extent on the quality of social institutions, as shown empirically by Hall and Jones (1999). As a proxy for formal sector productivity, we employ an often used variable (in this article, referred to as *InstEnv)* that measures the quality of the institutional environment in a country. Originally constructed by Knack and Keefer (1995), it has been used by for instance Hall and Jones (1999) and Olsson and Hibbs (2003). The variable exhibits the average coding over 1986-95 of five broad political-institutional characteristics, normalized to a 0 to 1 scale where the country with the best institutions score 1.

Data on levels and growth rates of GDP, investment ratios, life expectancy, and land area were collected from World Bank (2001). Average growth rates are calculated as (log GDP per capita 1999 - log GDP per capita 1990)/9. Growth rates range between 8.8% (China) to -11.7% (Moldova) with a mean at 0.3%. Transition countries from the former Soviet Union are overrepresented among the countries with the lowest growth.

5.3 Results

The simple relationship between economic growth and diamond abundance for 16 diamond producing countries where data was available, is shown in Figure 1. The variable used as a proxy for diamond abundance is DiaGDP. Figure 1 displays some evidence of a negative (but not significant) relationship between growth and diamond abundance. The extreme observation to the right is Botswana, which has a relatively high growth rate. When Botswana is included, a non-linear convex relationship fits the data points best. If Botswana is dropped, however, a linear negative coefficient becomes significant and R^2 rises from 0.12 to 0.40. A similar pattern arises also when the other indicators of diamond abundance are used.[13]

Does this relationship survive when we control for other variables? The first set of formal regression results is displayed in Table 2. The three independent variables at the top are control variables widely used in growth regressions (*LGDP1990* - Log GDP per capita in initial year 1990, *InvRat* - Gross capital formation as a share of GDP in 1990, and *LifExp* - Life expectancy at birth in 1990). Using initial levels arguably neutralizes any concerns of joint endogeneity between InvRat and the dependent variable. Might our measures of diamond abundance be positively correlated with LGDP1990? A simple Pearson correlation coefficient shows that the correlation is never higher than 10% and that the sign is actually negative.

As expected, LifExp has a positive and highly significant sign in all specifications. LifExp is usually interpreted as an indicator of the general quality of human capital. There is also evidence of conditional convergence in the Post-Cold War era; LGDP1990 is always negative and significant at the 10% level, implying that poorer countries, all else equal, tend to grow faster than richer ones. In line with what one would predict, the estimate of InvRat is positive, although never significantly so. The reason for this is that many transition countries like Russia had very high investment rates in 1990 and then experienced something of a growth collapse in the early 1990s.[14]

A dummy for the 27 former communist countries or Soviet republics in the sample (*Transit*) is always strongly negative and significant. Unlike many previous studies (for instance Sala-i-Martin, 1997), a dummy for Sub-Saharan Africa (*SSA*) is not at all significant and even shifts signs. This result does not change when a measure of diamond abundance is included. We have therefore dropped SSA in specifications (3)-(5).

The key results from Table 2 are those that are received by including our proxies for diamond abundance, DiaGDP, DiaArea, and DiVaAr. When Botswana is included, there is a convex relationship between growth and diamonds, even after controlling for other influences. The estimates for DiaGDP in (2) and (3) are negative and highly significant whereas the square

[13] Due to its outlier status in all regressions on growth and natural resources, Botswana has been a frequently analyzed example in the development literature (Acemoglu et el, 2001; Auty, 2001). The country will therefore not be extensively discussed in this article.

[14] Excluding transition countries from the sample makes InvRat positive and significant.

$(\text{DiaGDP})^2$ is positive and significant. The same holds for our other proxy, DiaArea, in (4). In this specification, p-values for DiaArea are very low, all control variables are highly significant except InvRat, and the adjusted R^2 is 0.43. The same basic pattern emerges when we regress our third indicator of diamond rents, DiViAr, on growth in (5).

Six more tests are carried out in Table 3. All specifications in Table 3 except (2) and (5) have used the four control variables in Table 2 as regressors, but they are not essential to this story, their estimates have been omitted. In specification (1), we have included the second variable in K; the institutions-variable *InstEnv*. In (1), the new regressor *(DiaGDP/InstEnv)* has been created by simply dividing DiaGDP by InstEnv. The prediction from Eq. (**??**) in the theoretical section is that this variable should be negatively related to growth. The variable provides an indicator of the strength of incentives for predation; a great diamond abundance coupled with weak social institutions should make predation more likely. Interestingly, it turns out that Congo-Kinshasa now gets the highest score (57.6) with Sierra Leone second (55.2). As hypothesized, (DiaArea/InstEnv) is negative and strongly significant in the growth regression.

One possible concern with our set-up so far is that diamond rents are correlated with institutional quality, which usually has a positive impact on growth. In (2), we therefore include DiaGDP and its squared value alongside InstEnv to see if the effect disappears. Due to the well-known strong correlation between InstEnv and some of our previous control variables (in particular initial income levels), the latter have been dropped in this specification. The result is that DiaGDP retains its strong convex relationship with growth while InstEnv is positive and significant. Going back to Figure 2, we can infer that differences in institutional quality account for at least some of the differences in growth between similarly diamond abundant countries such as Congo-Kinshasa and Namibia.

In the final four tests, we have varied our sample. In (3) and (4), the extreme observation Botswana has been excluded. The influence of this one observation is illustrated by comparing (1) with (3); the estimate for *(DiaGDP/InstEnv)* increases from -0.08 to -0.10 and R^2 rises from 0.40 to 0.44. It further turns out that the convexity results for DiaGDP no longer holds. A linear specification as used in (4) now fits the data best. As mentioned above, this seems to suggest that Botswana drives the convexity result. Without Botswana, the pure hypothesis in Proposition 4 of a negative relationship receives strong support.

Lastly, in (5) and (6), we have split our sample into Sub-Saharan Africa (including Botswana) and the rest of the world. As expected, our hypothesis works well for the countries in Sub-Saharan Africa. As is well known, institutional quality is very low in this region, implying that the payoffs from predation are relatively large, which in turn implies a negative relationship. The relationship is negative also for the rest of the world but not significant. In this sample of 86 countries, only 6 are diamond producers, which makes it difficult to draw any clear conclusions.

In summary, the regressions presented in this section display some support for the hypothesis of a negative relationship between diamond abundance and growth, in particular when extreme outlier Botswana is excluded. The pattern persists even after controlling for institutional environment and variables often used in growth accounting.

6 Conclusions

The curse of natural resources has been confirmed empirically by several studies. Much less progress has been made in understanding the source of the curse. This article focuses on the relationship between diamond abundance, appropriative conflict, and economic growth. By extending the conflict-theoretical framework created by Grossman (1991) and Hirshleifer (1991), we outline a model of a Stackelberg game between a ruler, in control of a flow of natural resource proceeds, and a potential predator. The link to output growth runs via a third agent; an ordinary, peaceful citizen who produces all official output and whose production is hurt by the appropriative struggle. In equilibrium, the model predicts that growth has a negative relationship with natural resource abundance if the country has weak institutions.

Out of all natural resources, diamonds are arguably the ideal reward for a potential predator due to their extremely high value per carat, their flexible practical size and scale of extraction, their indestructibility, their tradability all over the world, and the difficulty with which their place of origin can be established. Using data on growth, income per capita, and other variables for a large sample of countries, it is shown that three proxies for diamond abundance display a significant negative and convex relationship that becomes strictly negative when extremely diamond-abundant Botswana is excluded.

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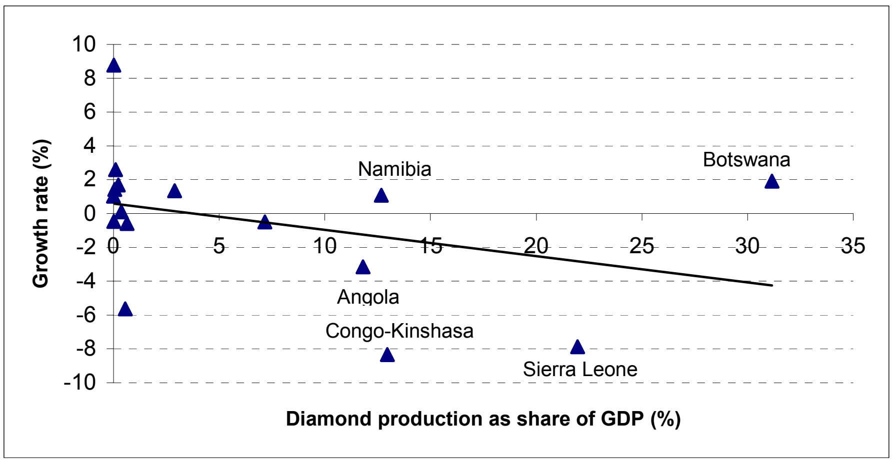
Table 1: Diamond production, growth, and war experience 1990-1999.

Country	Average Production 1990-99[1]	Gem Percentage[2]	Average Production per sq km	Average Growth 1990-99[3]	Civil War 1990-99[4]
Angola	1,732	90.24	1.39	-3.14	Yes
Australia	39,008	45.00	5.08	2.60	No
Botswana	17,563	74.94	30.98	1.91	No
Brazil	1,162	33.33	0.14	1.04	No
Canada	230	100.00	0.02	1.43	No
CAF	478	72.73	0.77	-0.50	No
China	1,083	20.00	0.12	8.78	No
Congo-Kinshasa	19,074	20.48	8.41	-8.33	Yes
Cote d'Ivoire	123	67.74	0.39	0.11	No
Ghana	686	80.19	3.02	1.69	No
Guinea	136	74.55	0.56	1.35	No
Liberia	85	60.00	0.89	n.a.	Yes
Namibia	1,326	94.57	1.61	1.09	No
Russia	20,250	50.00	1.20	-5.62	Yes
Sierra Leone	276	75.00	3.84	-7.86	Yes
South Africa	10,017	39.92	8.20	-0.58	No
Venezuela	265	62.11	0.30	-0.46	No
Zimbabwe	93	33.33	0.24	0.27	No
All	114,586	50.04	3.73	-0.37	-

[1] In thousands carats.
[2] Gemstone percentage of total production in 1999.
[3] In real GDP per capita (constant 1995 US$). Growth rate for Congo calculated between 1990-98.
[4] Refers to civil wars incurring more than 1,000 deaths.
Sources: Calculations based upon US Geological Survey (various issues), World Bank (2001), and Collier and Hoeffler (2001).

Figure 1: Relationship between diamond production as share of GDP in 1999 and average GDP per capita growth 1990-99.



Source: Calculations based on World Bank (2001) and US Geological Survey (various issues).

Table 2: Regressions on average growth rate of GDP per capita, 1990-1999.

	Growth rate of GDP per capita				
Independent variable	(1)	(2)	(3)	(4)	(5)
LGDP1990	-0.57 (.03)	-0.46 (.08)	-0.45 (.08)	-0.52 (.03)	-0.44 (.10)
InvRat1990	0.02 (.48)	0.01 (.61)	0.01 (.59)	0.001 (.98)	0.01 (.69)
LifExp	0.17 (.00)	0.15 (.00)	0.14 (.00)	0.16 (.00)	0.14 (.00)
Transit dummy	-5.18 (.00)	-5.07 (.00)	-5.08 (.00)	-5.01 (.00)	-5.05 (.00)
SSA dummy	-0.09 (.90)	0.16 (.84)			
DiaGDP		-0.47 (.00)	-0.47 (.00)		
$(\text{DiaGDP})^2$		0.02 (.01)	0.02 (.01)		
DiaArea				-0.69 (.00)	
$(\text{DiaArea})^2$				0.02 (.00)	
DiVaAr					-0.39 (.02)
$(\text{DiVaAr})^2$					0.01 (.00)
Adj. R^2	0.39	0.43	0.43	0.43	0.42
N	124	123	123	123	123

Notes: In parenthesis are *p*-values. Estimates of constants are omitted.

Table 3: Robustness tests.

	Growth rate of GDP per capita					
Independent variable	(1)[a]	(2)[a]	(3)[b]	(4)[b]	(5)[c]	(6)[d]
DiaGDP/InstEnv	-0.08 (.00)		-0.10 (.00)			
DiaGDP		-0.58 (.00)		-0.26 (.00)	-0.45 (.01)	-4.26 (.28)
$(\text{DiaGDP})^2$		0.02 (.01)			0.01 (.05)	
InstEnv		3.33 (.00)				
Adj. R^2	0.40	0.26	0.44	0.46	0.26	0.45
N	108	108	107	122	36	86

Notes: In parenthesis are *p*-values. In addition to the variables in the table, all specifications except (2) and (5) regress growth on four control variables (X={LGDP1990, InvRat1990, LifExp, Transit}) with unreported estimates. Specification (5) controls for all variables in X except Transit.

[a] Full sample.

[b] Full sample excluding Botswana.

[c] Only Sub-Saharan Africa.

[d] Full sample excluding Sub-Saharan Africa.