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 might increase the ruler's public utility investments, it might also lead to a crowding-out in favor of defense spendings, which depresses growth. As predicted by the model, a cross-country regression analysis suggests that diamond abundance has a 'U-shaped' relationship with economic growth.

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 rise to unproductive rent seeking that impedes economic development (Auty, 2001a). In general, there are good reasons to believe that the curse works

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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).

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. Defense spendings might thus crowd out public utilities and depress growth, in particular at low levels of resource abundance. The main result is a predicted 'U-shaped'-relationship between natural resource abundance and growth.

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, using data on 131 countries for the post-Cold War period, provides some support for the basic hypothesis of a convex relationship between diamond abundance and growth.

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).

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 uses 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. 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 summer 2003, a development towards peace has started in at least Congo-Kinshasa, Angola, and Sierra Leone, although the first country once again 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, a sequential game of appropriative conflict is presented where a predatory rebel is motivated by the prospect of conquering the rents from a natural resource endowment that is initially controlled by a ruler. The ruler, in turn, aims to maximize tax receipts and the rents from natural resources, and as a prey, he must defend his riches against the rebel. Stuck in the middle of the conflict is a peaceful citizen who delivers all of the country's formal output.

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 ethnical groupings 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; a current period and a previous period (in order to save notation, we will only index the previous period with a subscript -1). The two stages of the game are both played out in the current period. One time period should be thought of as a decade.

Rebel is something of an outlaw and does not take part in the formal economy of the country. Normally, he hides in the bush or in the mountains and lives off subsistence activities and predation. He might or might not reside in the country whose ruler he occasionally attacks.

Let us assume that Rebel controls a resource endowment l which represents the value of his total labor effort. Rebel splits his total effort between productive activities q and predatory activities a such that $l = a + q$. 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 γD where D is the world market value of natural resource extraction during a period of time and where γ is the share of that total value that Ruler diverts for his own personal enrichment.

Rebel's utility function is:

$$U_{Rebel} = p\delta\gamma D^{\alpha} + \eta q \tag{1}$$

The level of utility U_{Rebel} depends on revenues from natural resource predation (the first term) plus his output from peaceful subsistence production (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.[1] The exponent $\alpha < 1$ indicates that Rebel has diminishing marginal utility from predation. Like all other agents in this model, Rebel has myopic preferences.

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

Due to the violent conflict, a fraction $(1 - \delta)$ of the value is destroyed for both parties. This destruction is intended to capture both the direct costs of conflict as well as the fall in price on natural resources that the two fighting parties receive abroad because of the bad publicity that the conflict arouses. It might even be the case that sanctions are imposed, which makes δ very low. The direct costs of war depend on several factors such as the kind military weaponry needed, the geography in which a civil war is fought (Collier and Hoeffler, 2001), the strength of connections with a helpful diaspora of countrymen or with a superpower (Collier and Hoeffler, 2001), and the degree of ethnic fractionalization that influences the costs of coordination (Collier, 2000a). The 'post-conflict' value of the appropriable, extracted resources is therefore $\delta\gamma D$ and the effective utility of Rebel's conquest is $p\delta\gamma D^{\alpha}$.

Output from peaceful subsistence is given by the extremely simple 'AK'-production function ηq where η is a productivity parameter. Peaceful production is the opportunity cost of predation.

[1] What this implies is that when Rebel considers starting a 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).

The share of natural resources that Rebel conquers is given by a function describing the 'technology of conflict':[2]

$$p = \frac{a}{a+b} \tag{2}$$

As mentioned above, a is the effort that Rebel devotes to predation whereas the new variable b reflects the resources that Ruler spends on defending his personal natural resource endowment γD. At any level $b > 0$, an increase in Rebel's predation effort a increases the fraction that Rebel captures and vice versa. More precisely, it is easily shown that p is positive and concave in a and negative and convex in b. $a+b$ might be thought of as the total resources in society allocated to appropriative conflict.

Peaceful Citizen does not take part in any appropriative conflict and is neutral in the struggle between Ruler and Rebel. Consequently, Rebel does not prey on Citizen and Ruler allocates no resources to fighting Citizen.[3] Citizen stands for the country's total formal production and the level of current-period output is also given by a linear production function

$$y = A\left(h+k\right). \tag{3}$$

A is a productivity or 'social infrastructure'-parameter capturing aspects like the level of technology, environmental factors, or the quality of government policy prevailing in the country's formal sector. h is Citizen's level of human capital whereas k is the stock of physical public utilities like roads, electricity, and water provided by Ruler. Note that unlike Rebel, Citizen can fully utilize k. It will be assumed that human capital grows according to a process $h = h_{-1}\left(1+v\right)$ where $v > 0$ might reflect learning-by-doing effects.

In order to finance the day-to-day administration of the state, Ruler taxes Citizen with a marginal income tax rate of $\tau < 1$. This tax rate is assumed to be the one that maximizes Ruler's tax receipts $\tau \cdot A\left(h+k\right)$. At levels higher than τ, Citizen will start to shirk so that net tax incomes fall. τ might thus be seen as a measure of Citizen's tolerance of Ruler's rule. Ruler does not attempt to tax Rebel who is hiding in the bush. Citizen's after-tax income is always higher than Rebel's maximum income from peaceful work: $(1-\tau) \cdot A\left(h+k\right) > \eta l$. If it were not, Citizen would have an incentive to take up subsistence agriculture in the jungle and become an outlaw rebel.[4] Citizen's objective is simply to retain as much output as possible after taxation.

Lastly, we need to describe the objectives of Ruler. Ruler controls two types of income streams; the tax payments T from Citizen and the proceeds

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

[3] 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.

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

from selling one period's extraction of natural resources on the world market D. Tax receipts are only used for basic state administration and do not flow back to Citizen. Natural resource rents might come to Citizen's benefit, however. Ruler makes three uses of D: Personal enrichment, public utilities, and defense spending. By defense spending, we refer to resources devoted to secure the rents that Ruler has diverted, not to defending Citizen or the country in an ordinary sense. As was mentioned above, Ruler retains a fraction γD for his own personal enrichment. The fraction γ might be anything from zero in the case of a benevolent Ruler, to close to one. We will assume here that γ is an exogenous parameter, but an extension of our model could easily make it an endogenous variable. The personal enrichment might take several different forms.[5] The key characteristics of γD are firstly that the stock is unproductive since it is withdrawn from the formal economy, and secondly that it is appropriable, in other words, it is the object of the predatory Rebel's conquest ambitions.

Ruler uses the remaining value $(1-\gamma)\,D$ for investments in public utilities $(k-k_{-1})$ and for private defense spendings b. Investment in public utilities is normally positive, but we do not rule out the possibility of a negative investment $(k-k_{-1}<0)$, which means that Ruler converts parts of the previous period's stock of utilities into defensive fortifications. Ruler cannot use tax receipts for the financing of $(k-k_{-1})$ and b since T is fully used up by the state administration. Taken together, Ruler thus faces the budget restriction:

$$(k-k_{-1})+b=(1-\gamma)\,D \tag{4}$$

Finally, Ruler's utility is a simple additive function of his personal enrichment and tax receipts:

$$U_{Ruler}=(1-p)\,\delta\gamma D^{\beta}+\tau A\,(h+k) \tag{5}$$

If there is a battle against Rebel, Ruler rescues a share $(1-p)\,\delta$ of his wealth where p was defined above. Ruler receives diminishing utility from an extra unit of natural resources $(\beta<1)$. For technical reasons, we will make the assumption that the relation between Ruler's and Rebel's risk aversion parameters is $(\beta-\frac{\alpha}{2})\in\left(0,\frac{1}{2}\right)$. This assumption allows both for the possibilities of $\beta>\alpha$ and $\beta<\alpha$ but restricts their differences in size. An admissible and plausible scenario is simply that $\alpha=\beta$.

Although Ruler cannot use tax income to expand his personal wealth, he still gets utility from controlling a large government administration. Note that Ruler only indirectly (via tax receipts) receives utility from the current level of national output $A\,(h+k)$.

[5] Ndikumana and Boyce (1998) describe how the enrichment strategies of Zaire's dictator Mobutu (who probably had a γ close to 1) included direct transfer of enormous proceeds from natural resource exports to presidential accounts, as well as smuggling of diamonds out of the country. See also Bigsten and Moene (1996) for various forms of rent diversion in Kenya.

3.2 Equilibrium

Let us assume that Ruler and Rebel allocate their current period resources in a two-stage, sequential game. Ruler, who might be regarded as a Stackelberg leader, moves first and decides on what proportions that should be used for his private defense (b) and for investment in public utilities ($k - k_{-1}$), taking into account the likely response from Rebel in terms of levels of predation (a) and production efforts (q).[6] In the second stage, Rebel makes his actual move and takes Ruler's choices 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 and q that maximize his utility function, taking Ruler's observed choices b and $(k - k_{-1})$ as given. By inserting $q = l - a$ and (2) into (1), we can define the optimization problem:

$$\max_{a} \frac{a\delta\gamma D^{\alpha}}{a+b} + \eta\,(l-a) \tag{6}$$

The first-order conditions for this problem are:

$$\frac{\partial U_{Rebel}}{\partial a^{*}} = \frac{\delta\gamma D^{\alpha}}{a^{*}+b} - \frac{a\delta\gamma D^{\alpha}}{(a^{*}+b)^{2}} - \eta : \begin{array}{ll} \leq 0, & a^{*}=0 \\ = 0, & a^{*}>0 \end{array} \tag{7}$$

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 ($q = l$). Hence, we can deduce a condition stating that no predatory activity will take place if

$$D \leq \left(\frac{b\eta}{\delta\gamma}\right)^{\frac{1}{\alpha}}.$$

The lower row in (7) 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:

$$a^{*} = \sqrt{\frac{b\delta\gamma D^{\alpha}}{\eta}} - b \tag{8}$$

(8) defines all responses that Rebel makes to a given level of Ruler's chosen defense level b. Simple calculus shows that a^{*} is a positive or negative, concave function of b. Hence, at low levels of b, an increase in Ruler's strength increases Rebel's predatory efforts whereas beyond a certain level, Rebel's predatory effort decreases with b.[7]

[6] 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.

[7] The critical level of b turns out to be $b^{c} = \frac{\delta\gamma D^{\alpha}}{4\eta}$.

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. We might also rewrite the budget restriction in (4) into $k = k_{-1} + (1-\gamma) D - b$. Ruler's maximization problem then becomes

$$\max_{b} \sqrt{b\delta\gamma\eta} \cdot D^{\beta-\alpha/2} + \tau A(h + k_{-1} + (1-\gamma) D - b). \tag{9}$$

Taking the first-order condition for maximum, we can solve for Ruler's equilibrium level of defense effort:

$$b^* = \frac{\delta\gamma\eta D^{2\beta-\alpha}}{4(\tau A)^2} \tag{10}$$

With b^* at hand, we can easily derive the equilibrium levels of conflict intensity, conquest, and growth and perform comparative statics.

3.3 Comparative Statics

If we define total effort devoted to appropriative conflict as a measure of conflict intensity, we can utilize (10) and (8) to form the following expression:

$$a^* + b^* = \frac{\delta\gamma D^{\beta}}{2A\tau} \tag{11}$$

From this surprisingly simple equation, we obtain some important results:

Proposition 1 *Equilibrium conflict intensity increases with δ, γ, and D, and decreases with A and τ.*

Proof. The results follow from straightforward differentiation. ■

Hence, the model predicts that social conflict will be more intense when rulers enrich themselves to a great extent so that γ is high. In fact, in countries where the government is totally benevolent ($\gamma = 0$), there will be no social conflict at all, regardless of the quantity of natural resources. Furthermore, if the fighting is not too costly, conflict will also be more intense (a high δ). A high level of productivity in the formal sector A and a high accepted level of taxation τ both increase the opportunity cost of conflict. The key result for the argument in this article, however, is that the level of conflict will increase with the value of extracted natural resources, D.

Next, the equilibrium share of appropriable natural resources that Rebel manages to conquer is

$$p^* = \frac{a^*}{a^* + b^*} = \frac{2\tau A - \eta D^{\beta-\alpha}}{2\tau A}. \tag{12}$$

Rebel's success (and Ruler's corresponding level of failure) is thus mainly a function of natural resource abundance and tax compliance:

Proposition 2 *The equilibrium share of appropriable resources that Rebel conquers increases with τ and A, decreases with η, and increases with D if $\alpha > \beta$.*

Proof. The results follow from straightforward differentiation. ■

The expression in (12) describes the realized success of a predatory rebel group.[8] Rebel's success is positively related to Citizen's productivity A and willingness to pay taxes τ. High levels of A and τ mean that it is relatively more beneficial for Ruler to provide public utilities for tax-paying Citizen rather than spending money on defense. Therefore, b^* would be smaller and p^* greater than otherwise. A high productivity in Rebel subsistence production η implies that the opportunity cost of predation is high, which lowers the equilibrium share of conquered resources. The intuition about D is simply that if Rebel is more positive towards risk than Ruler so that $\alpha > \beta$, an increase in natural resources will increase Rebel's relative success in the conflict, and conversely. It can even be shown that if $\alpha > \beta$, then we actually have that $\lim_{D \to \infty} p^* = 1$, that is Rebel takes it all at extreme levels of resource abundance.[9]

Lastly, and most importantly, we will make some comparative statics on the growth of formal output. From (3), we know Citizen's current level of output, which is identical to the total level of current aggregate output. Analogously, let us assume that previous period's total output was $y_{-1} = A\left(x_{-1} + k_{-1}\right)$. We also make the important assumption that this initial level of income y_{-1} is independent of D, in other words we treat y_{-1} as a constant.[10] We will further make use of the derived equilibrium level k^* and the fact that $h = (1+n)\, h_{-1}$. With all this information, we can formulate a growth expression:

$$g = \frac{y - y_{-1}}{y_{-1}} = \frac{A\left[h - h_{-1} + k^* - k_{-1}\right]}{y_{-1}} = \tag{13}$$
$$= \frac{A\left[nh_{-1} + (1-\gamma)\, D - \frac{\delta\gamma\eta D^{2\beta-\alpha}}{4(\tau A)^2}\right]}{y_{-1}}$$

Growth of aggregate output thus depends on the growth rate and intital level of Citizen human capital nh_{-1}, on Ruler's investment in public utilities $(k^* - k_{-1})$, and on intial level of income y_{-1}. The accumulation of human capital and initial income is exogenously given and the key to the story is thus investment in public utilities.

First, it is worth noting that Ruler's investment is a directly negative function of his private defense spending b and that the link between growth and appropriative conflict runs via public utility provision. In extreme situations, it might even be the case that $(1-\gamma)\, D < b^*$. This would imply a negative public investment $(k^* - k_{-1} < 0)$, i.e. that Ruler confiscates existing public

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

[9] One might of course question if Ruler can still be considered to be a ruler of the country if Rebel manages to grab a share in the vicinity of 1. We will disregard such aspects here.

[10] In the empirical section, we will show that whereas there is a clear relationship between growth and natural resource abundance in the form of diamonds, there is no correlation between natural resource abundance and initial income.

utilities in order to turn them into defense structures. Should nh_{-1} further be small, this might result in a negative growth rate.

Secondly, comparative statics on (13) gives the following results:

Proposition 3 *The equilibrium growth rate of aggregate output decreases with* γ*,* δ*,* η*, and* y_{-1}*, increases with* n*,* A *and* τ*, and decreases with* D *if* $D < \left[\frac{\delta\gamma\eta(2\beta-\alpha)}{4(1-\gamma)(\tau A)^2}\right]^{\frac{1}{1+\alpha-2\beta}}$.

Proof. The results regarding γ, δ, η, A and τ are straightforward. The first derivative of the growth rate with respect to natural resource abundance yields: $\frac{\partial g}{\partial D} = \frac{A(1-\gamma)}{y_{-1}} - \frac{\delta\gamma\eta(2\beta-\alpha)D^{2\beta-\alpha-1}}{4A\tau^2 y_{-1}}$. Recalling the assumption that $2\beta - \alpha = 2\left(\beta - \frac{\alpha}{2}\right) < 1$ assures us that D's exponent $2\beta - \alpha - 1$ is negative and that the second derivative therefore is positive. g thus attains a minimum at $D^{\min} = \left[\frac{\delta\gamma\eta(2\beta-\alpha)}{4(1-\gamma)(\tau A)^2}\right]^{\frac{1}{1+\alpha-2\beta}}$. ■

Since γ, δ, and η all have been shown to increase Ruler's defense spending, they will decrease public investments and growth, whereas the contrary is true for A and τ. If, for instance, Ruler is perfectly benevolent so that $\gamma = 0$, then b^* will be zero and growth will be positive with certainty.

The central result of the proposition concerns D. An increase in natural resource rents has two effects: To increase Ruler's income and hence his spending on public utilities, but also to increase the stock of appropriable rents, which means that Ruler optimally spends more on defense so that public utility investment is crowded out. The relative strength of these influences determines the sign of the derivative.

In turns out that at moderate levels of natural resource abundance, an increase in D will have a larger effect on b^* and hence depress growth. Beyond the minimum level $D^{\min}$, however, the positive impact of increases in D will dominate and growth will increase with D. What the model predicts is thus a possible 'U-shaped' relationship between growth and natural resource rents, as shown in Figure 1. The area to the left of $D^{\min}$ displays the 'curse of natural resources' where higher levels of D are transformed into more conflict. Equivalently, the area to the right is the 'blessed' region where growth increases with D.

The empirical record so far seems to indicate that most countries are in the 'cursed' region of Figure 1 (Sachs and Warner, 1997, 2001). Why might this be the case? The expression for $D^{\min}$ suggests several possible explanations. A high $D^{\min}$ indicates that the cursed region is large. Thus, high levels of γ and δ imply a large cursed region. Most importantly, however, and perhaps the key to understanding why so many developing countries appear to be stuck in the cursed region, is poor levels of productivity A. Low levels of A mean that Ruler's opportunity cost of defensive conflicts against predatory rebels is low and that natural resources will mainly be a prize and a curse that hampers growth.[11]

[11] In their predator-prey model, Mehlum et al (2003) show that countries might get stuck

4 Diamonds Are A Rebel's Best Friend

Several different kinds of natural resources have served as rewards for rebellions and as sources of personal wealth to dictators (see for instance Collier, 2000b or Olsson and Congdon, 2003). 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 low δ. 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,

in a 'Predators' Club' of persistent poverty and predation.

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 convex function of natural resource rents D such that an increase in D will be negatively related to growth at moderate levels of D whereas growth will have a positive relationship with increases in D at higher levels of D. The chain of causality runs from resource incomes D to Ruler's defense spendings b which crowd out public utility investments and decrease 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. In the empirical section below, 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. We will also use a measure of institutional quality as a proxy for A. The other possible sources of influence, like γ, 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 $\boldsymbol{\varepsilon} \sim N\left(0, \upsilon^2\right)$ 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, a proxy for productivity. 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 convex relationship between growth and diamond rents D. $\mathbf{X}$ 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 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 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

[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.

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 2. The variable used as a proxy for diamond abundance is DiaGDP. In line with what was predicted in Figure 1, Figure 2 displays evidence of a convex relationship between growth and diamond abundance with a negative slope for the group of countries with an abundance smaller than 15. The somewhat extreme observation to the right is Botswana, which has a relatively high growth rate. A convex curve as that shown in the figure gives a surprisingly good fit to the observations ($R^2 = 0.33$). The simple relationship suggests that all countries except Botswana and possibly Sierra Leone are in the cursed region described in Figure 1. The equivalent of $D^{\min}$ turns out to be $DiaGDP = 16.5$ at which level the implied growth rate is roughly -4.5%.

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.[13]

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 and DiaArea. In line with what was hypothesized above, there appears to be 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 $(\text{DiaGDP})^2$ 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). We interpret these results as giving some support to our conjecture of a U-shaped relationship between diamond rents and growth.

In order to check the robustness of our results, we have performed six more tests in Table 3. All specifications in Table 3 except (2) and (5) have used the four control variables in Table 2 as regressors, but since their estimates 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. A similar set-up is suggested by Equation (13) in the theoretical section. The resulting variable provides an indicator of the strength of incentives for predation; a great diamond abundance coupled with

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

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 before, this seems to suggest that Botswana is the only clear example of a country that has an abundance high enough to have escaped the curse of natural resources.[14] The result might, on the other hand, also be interpreted as a partial rejection of our U-shape hypothesis since the pattern appears to hinge on a single observation and therefore cannot be regarded as robust. More research is needed to resolve this issue. It should be noted, however, that there is still strong support for the theoretical prediction in Proposition 3 of a negative relationship between growth and diamond rents at low to medium levels of abundance. In line with our model, it might indeed be the case that the true $D^{\min}$ is presently beyond all countries' endowment.

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 Sub-Saharan Africa. As is well known, productivity and institutional quality are low in this region, implying that the payoffs from predation are relatively large, which in turn implies a clear U-shaped relationship with a large 'cursed' sequence along the D-curve (Figure 1). 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 or U-shaped relationship between diamond

[14] 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.

abundance and growth, in particular for Sub-Saharan Africa. The pattern persists even after controlling for institutional environment and variables often used in growth accounting. However, the issue of whether Botswana is an extreme outlier or the only country that has reached the positive section of the 'U', remains an open question.

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 or U-shaped relationship with natural resource abundance.

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 sample of 131 countries, it is shown that three proxies for diamond abundance display a significant negative and convex relationship with growth, as predicted. The basic result of a negative relationship remains intact even after the exclusion of extremely diamond abundant Botswana.

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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: Predicted relationship between natural resource (diamond) abundance and growth.

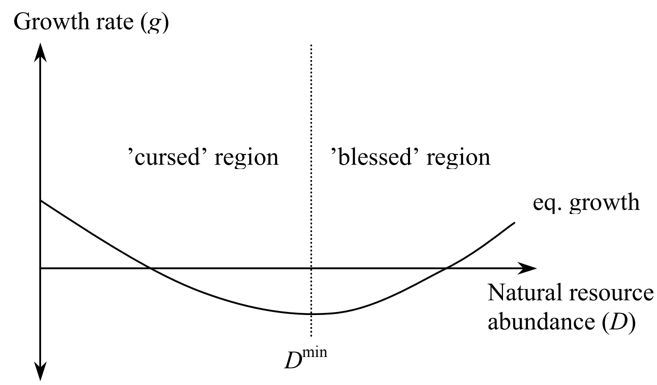
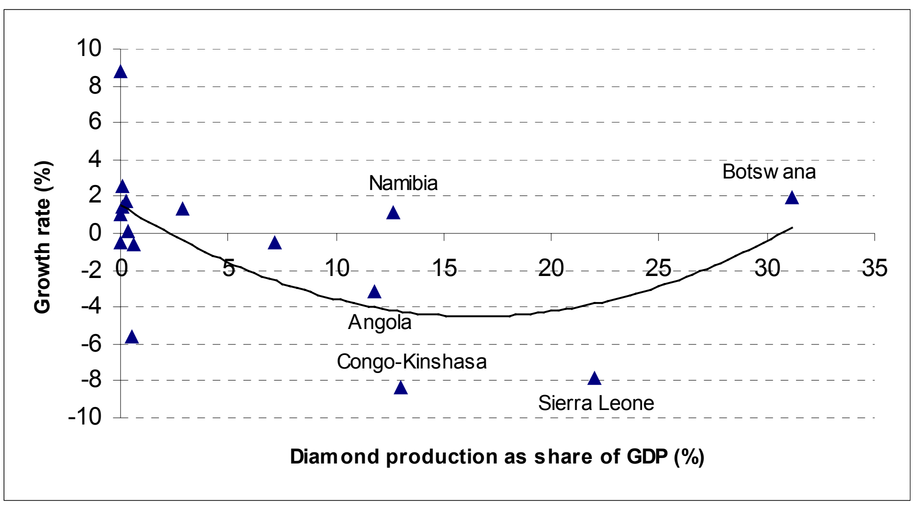


Figure 2: Relationship between diamond production as share of GDP in 1999 and average GDP per capita growth 1990-99.



Source: Calculations based on World Bank (2001) and US Geological Survey (various issues). The fitted curve has been obtained through nonlinear least squares.

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)
$(DiaGDP)^2$		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.