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ABSTRACT

Development and Growth in Mineral-Rich Countries*

This paper describes some of the ways in which mineral rents and their management influence economic growth and other determinants of growth as well as some of the reasons why many mineral-rich countries have not managed very well to divert their resource rents to furthering economic and social development – that is, why natural capital tends to crowd out human, social, financial and real capital. The empirical evidence of these linkages is presented in two rounds. First, we allow World Bank data covering 164 countries in 1960-2000 to speak for themselves through a sequence of bilateral correlations that suggest an inverse relationship between natural resource dependence and growth via human capital. We then repeat the exercise for two aspects of social capital, corruption and democracy, suggesting an additional adverse effect of natural resource dependence via social capital on growth. In the second round, we test for the robustness of natural resource dependence as a determinant of long-run growth by estimating a series of growth regressions for the same 164 countries.

JEL Classification: O11
Keywords: economic growth, natural resources and social policy

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1. Introduction

Social development and economic growth are closely intertwined. Social indicators – of life expectancy, fertility and literacy, for example – convey a clear and consistent picture of rapid progress around the world in recent decades, sometimes a more transparent picture than do more commonly used economic indicators. Since 1960, the people of China have seen their life expectancy increase by nine months per year; in India, by four to five months; in Ghana, by more than three months. The sources of greater prosperity and longer lives are gradually becoming better understood, especially the economic forces such as investment, education, trade and economic stability, to name but a few of the determinants of growth identified before the advent of modern growth theory by philosophers and economists from Adam Smith to W. Arthur Lewis and Robert M. Solow. Diversification away from excessive dependence on natural resources, including minerals, has been identified as a possible additional source of growth through assorted channels that will be discussed in what follows. The role of political and social forces in economic development is less well understood, however, so this is where we begin.

A. Inequality and growth

Apart from education and health care, social policy issues have been strangely absent from much of the recent academic debate of economic growth. A relatively small part of the literature that deals with the relationship between income distribution and economic growth is an exception. In theory, the relationship between distribution and growth is ambiguous and complex. Some authors, including both Karl Marx and early Keynes (1920), have argued that income inequality, through large numbers of rich people inclined to save, is an important catalyst of real capital accumulation and growth. This linkage is based on the presumption that the marginal saving rates of households increase with disposable incomes, a proposition that receives some support from empirical studies. If this is so, redistribution of income from rich people to poor people would reduce saving, investment and growth. This linkage, however, is likely to weaken in the presence of free movement of capital across national boundaries because capital mobility weakens the link between domestic saving and domestic investment (but the link does not break owing to imperfect goods market integration).

On the other hand, income inequality seems likely to slow down the accumulation of human capital and thereby reduce economic growth over long periods – by which is meant either long-run growth in the sense of endogenous growth models (Romer 1994) or medium-

term growth in the sense of the Solow model (see Solow 1970). One of the reasons for this relationship between distribution and growth is that redistribution of income from rich people to poor people is likely to result in more human capital, less real capital, more output, and probably also more rapid growth of output because the rate of return on human capital investments by the poor typically exceeds the return on real capital investments by the rich (Galor and Moav 2004). Likewise, in developing countries, a transfer of resources from the university education of the rich to the more elementary education of the poor would *per se* lift output and growth because primary education as a rule offers higher rates of return than tertiary education (Hall and Jones 1999; see also Pritchett 2001). Later, Keynes extended his earlier view of the problem by suggesting in the *General Theory* (1936) that high saving rates among the rich tend to discourage growth by reducing effective demand, but this was before growth theory had established a clear distinction between the short run where high saving rates tend to depress the level of income and the longer run where high saving rates have the opposite effect on income.

A combination of the two strands of the relationship between inequality and economic growth produces the Kuznets curve which describes how income inequality tends to increase with income at low levels of income and to decrease with income at higher levels of income (Kuznets 1955). One possible interpretation is as follows. In early stages of development, when investment in physical capital is the main engine of economic growth, inequality spurs growth by directing resources toward those who save and invest the most, whereas in more mature economies human capital accumulation replaces physical capital accumulation as the main source of growth, and inequality impedes growth by hurting education because poor people cannot fully finance their education in imperfect credit markets where human capital cannot be used as collateral. In developing countries, however, increased supply of qualified labour does not necessarily create its own demand. A positive macroeconomic effect of more and better education on growth requires appropriate employment opportunities for qualified labour. Even so, a positive microeconomic effect of education on the living standards of poor people seems hard to dispute. An African proverb states the matter succinctly: Educate a boy, and you educate one individual; educate a girl, and you educate a whole family, a nation.

Some observers fear that income inequality endangers social cohesion, political stability, and peace and may thus spoil the investment climate as well as triggering counterproductive demands for redistribution, thus reducing efficiency and growth (Alesina and Perotti 1996). Moreover, poor people lack the collateral necessary for them to be able to borrow to finance productive investments in real capital as well as human capital, so by reducing the number of

poor people redistribution from rich to poor is likely to enhance efficiency and economic growth (Galor and Zeira 1993). Further, Garcia-Peñalosa (1995) argues that rich countries differ from poor ones in that increased inequality discourages education and growth in rich countries by increasing the number of poor people who cannot afford to educate themselves or their children whereas increased inequality encourages education and growth in poor countries by increasing the number of rich people who can afford education.

Because the theory of the relationship between inequality and growth is grounded in different paradigms and covers a variety of causal mechanisms and feedbacks, it is not surprising that is has given rise to conflicting conclusions. Inequality is the combined result of macroeconomic mechanisms and public policies that influence market outcomes, including the distribution of income. Given that inequality and economic growth can both be viewed as endogenous macroeconomic variables, it is hardly surprising that they can move either in the same direction in some circumstances or in opposite directions in others depending on the constellation of forces that influence both. Unsurprisingly, therefore, the empirical literature, like the multi-faceted theoretical literature behind it, is also somewhat ambiguous and inconclusive. Several studies report that inequality is detrimental to growth across countries (e.g., Alesina and Rodrik 1994; Persson and Tabellini 1994; Perotti 1996; and Gylfason and Zoega 2003). Others disagree. Barro (2000) finds that increased inequality is good for growth in poor countries and bad for growth in richer countries, but he finds no support for a relationship between inequality and growth one way or the other in his sample of rich and poor countries as a whole. Forbes (2000) reports a positive relationship between inequality and growth in a pooled cross-country regression with country effects included.

Another sign of the limited attention paid in recent literature to the possible interaction between social policies and economic growth is the standard treatment accorded government expenditure as a potential determinant of growth. In empirical work, it has been common practice to exclude defence expenditure, and sometimes also noncapital expenditure on education, from total government expenditure, apparently on the double but dubious presumption that (i) defence, like education, is good for growth – in growth regressions, education is commonly included *per se* among the main determinants of growth – and (ii) the rest of government expenditure does not directly affect productivity, but rather entails distortions of private decisions, thus reducing growth (as clearly stated in Barro and Sala-i-Martin 2004, pp. 518-519). Yet, Knight, Loayza and Villaneuva (1996) report that military expenditures tend to inhibit growth through their adverse effects on capital formation and resource allocation. Furthermore, there are strong *a priori* as well as empirical grounds for

believing that social expenditure and, more generally, social policies do matter for economic growth, which brings me to my main point in this paper.

B. Organization

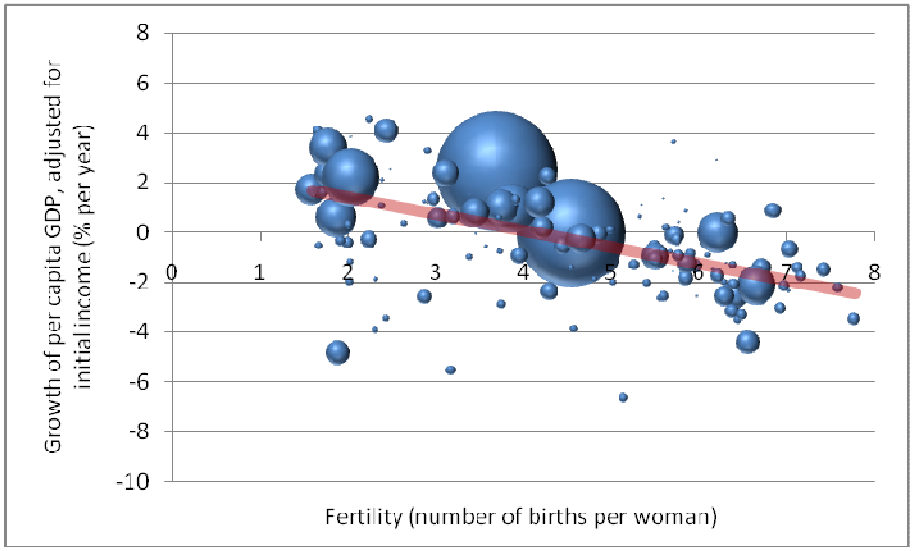
So my point of departure in Section 2 will be that social development in a broad sense is an integral part of economic growth and that, therefore, social policies must matter for growth. Put differently, the level and composition of government expenditure must make a difference for growth just as the composition of private expenditure between consumption and investment matters for growth, but this aspect of the topic at hand – that is, the relationship between government expenditure and growth – lies outside the scope of this paper. In Section 3, we take a quick look at the mineral-rich countries, who they are, how some of them have fared over the years, including how much they have spent on education and health care compared with other countries with similar incomes and fewer natural resources. Section 4 deals with some of the several ways in which mineral rents and their management influence economic growth and other determinants of growth as well as some of the reasons why many mineral-rich countries have not managed very well to divert their resource rents to furthering economic and social development – that is, why natural capital tends to crowd out human, social, financial and real capital. Section 5 offers some cross-country empirical evidence of the linkages among mineral wealth dependence, economic growth and social outcomes. Section 6 summarizes the story, and concludes by emphasizing the need for political as well as economic diversification away from excessive dependence on natural resources and narrowly based political elites.

2. Social policy matters for growth

One of the starkest cross-country correlations in development economics is the inverse relationship between fertility and economic growth. Figure 1 illustrates this correlation by showing the cross-sectional pattern of fertility as measured by the average number of births per woman 1960-2000 on the horizontal axis and the average per capita rate of growth of gross domestic product (GDP) over the same period, adjusted for initial income, on the vertical axis. The adjustment was made by first regressing per capita growth on initial income to isolate the catch-up or convergence effect of initial income on growth and then subtracting the contribution of initial income to growth from the recorded growth figures to produce an alternative series of growth numbers net of the initial income effect – that is, net of the

convergence effect through which poor countries tend to grow more rapidly than richer ones (Barro and Sala-i-Martin 1992). The idea behind the catch-up or convergence effect is that developing countries have yet to exploit several of the growth opportunities open to them, opportunities that richer countries have already been able to exploit, and that, therefore, poor countries can expect to grow more rapidly than richer ones. In Figure 1, the Spearman rank correlation between fertility and growth in this sample of 164 countries is -0.62.[1]

Figure 1. Economic growth and fertility 1960-2000



Source: Author's computations based on data from World Bank (2007).

Each country in Figure 1 is represented by a bubble the size of which is proportional to the country's population in 2000. Hence, for starters, China and India are easy to spot in the figure. The slope of the regression line through the scatter of bubbles in Figure 1 suggests that a reduction in the number of births per woman by three from one country to another goes along with an increase in the per capita growth rate of two percentage points per year. The link between fertility and growth is strong economically as well as statistically.

A. Why fertility matters for growth

There are two different reasons to expect reduced fertility to have an encouraging effect on economic growth as shown in Figure 1. The first of these is the population growth drag built

[1] There is also a strong negative correlation between fertility and growth without the adjustment for initial income. The same applies to all other correlations exhibited in the paper: they hold with or without the adjustment of per capita growth for initial income.

into the Solow model. Natural resources are a fixed factor of production that inhibits potential economic growth, causing a growing population and a growing stock of capital to run into diminishing returns. This also helps explain the inverse relationship between natural resource wealth and economic growth reported in recent literature, more of which later. Nordhaus (1992) shows that the long-run rate of growth of per capita output in an economy dependent on natural resources is proportional to the rate of technological progress minus a factor that is also proportional to the sum of the population growth drag due to diminishing returns and a natural resource depletion drag due to declining levels of exhaustible natural resources (Gylfason and Zoega 2006). This matters because population growth is inversely related to fertility within countries as well as across countries.

The second reason for an inverse relationship between fertility and growth has to do with human capital. This is where social policy enters the picture. One of the keys to increased prosperity around the world is the persistent trend from short lives in large families to long lives in small families. Birth rates have declined sharply all over the world for a number of reasons, including lower death rates and the increasing cost of rearing children. Lower birth rates and reduced population growth enable parents to provide better care for each of their children and thereby to increase their average "quality." This parents can do by offering each one of their children more and better education, health care and other opportunities and amenities that the parents otherwise could not afford. A good education then ceases to be the privilege of the eldest son, a common occurrence in poor countries. From this perspective, reduced fertility can be viewed as a form of investment in human capital, intended to increase the quality and efficiency of the labour force as well as individual happiness.

A third possibility is to view both fertility and growth as endogenous variables that can move in the same direction or in opposite directions depending on how the wind blows. In China, government policy has been directed at reducing fertility and boosting growth with the intended result on both counts. Other governments may want to try to raise both fertility and growth through tax and transfer policies, for example, a relevant concern in some OECD countries where population growth has recently been slow, or even negative (Germany 2005).[2]

In many developing countries, especially in Sub-Saharan Africa, the decline in birth rates has been disappointingly slow. A likely explanation for this is that, in many low-income

[2] Iceland, Turkey, and the United States were recently the sole OECD countries whose birth rates exceeded the critical replacement rate, 2.1 births per woman. In other OECD countries, the population would decline without net immigration from abroad. In 2005, the average birth rate in the European Monetary Union was 1.5 (World Bank 2007).

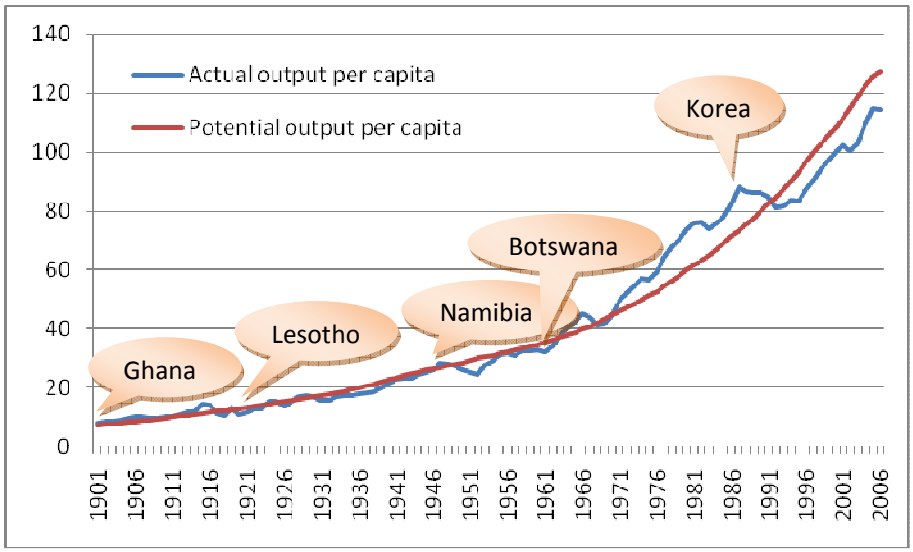
countries, large families are commonly viewed as a substitute for social welfare of the kind provided to different degrees by the government in high-income countries. Lacking the real thing, parents view a large number of children as a method of social insurance in that one of a large number of children is more likely than one of just two or three children to stay behind to take care of aging or ailing parents. Social welfare reforms of the kind launched by Chancellor Otto von Bismarck in Germany around 1880, including a national program of health, accident, and old-age insurance that gradually expanded to other areas and became the hallmark of European welfare states, created conditions in which, with the passage of time, a large number of children was no longer necessary or desirable from the parents' point of view. This, in turn, made it possible for ever increasing numbers of young people to acquire a good education and leave the land for urban areas. This helps explain how in the 20th century Europe became rich, and also America. This is the path that many middle-income countries have chosen and that low-income countries also need to take to catch up with the high-income countries. An obvious implication of this argument is that developing countries need social insurance, including health insurance and comprehensive old-age pensions, to break the path toward smaller families, more and better education, longer lives, and higher standards of living. Through their contribution to the build-up of human capital, and also social capital, social policies can thus be an essential ingredient of economic development. This line of argument does not depend on which comes first, reduced fertility or increased income. They go hand in hand: the direction of causation runs both ways, but this is immaterial here. Either way, family planning aimed at reducing birth rates in poor countries is an essential ingredient of economic and social policies aimed at boosting economic growth just has time may have come for family planning intended to increase birth rates in some high-income countries.

The main point of this discussion is that public policies aimed at enhancing social welfare in a broad sense, including pensions, social assistance, family benefits, and unemployment insurance as well as comprehensive health care and education, are an inseparable aspect of economic growth, and of widely shared growth in particular. The story of fertility and growth recounted above is a piece of a much broader mosaic, and is not intended to suggest that the poor should be asked to have fewer children than the rich, far from it. Clearly, reproductive rights and the freedom to decide the size of one's family are crucial human rights. Sound economic and social policies need to aim to improve living conditions for all and to allow them, in the words of Amartya Sen, to live the life they have reason to value. In the empirical analysis in Section 4, some of these elements will be lumped together with others, including social cohesion and democracy, under the heading of social capital.

B. When Iceland was Ghana

In this context it is important to remember that, in 1900, two decades after the Bismarck's launch of the European welfare state, parts of Europe were no richer than, for example, Ghana is today. Figure 2 shows that, in 1901, Iceland's per capita GDP was about the same as that of today's Ghana, measured in international dollars at purchasing power parity (PPP). The uneven trajectory in Figure 2 shows Iceland's actual per capita GDP, whereas the smooth one shows Iceland's potential per capita output, conventionally estimated by a simple regression of the logarithm of actual per capita GDP on time to abstract from business cycles.

Figure 2. Iceland's per capita output 1901-2006 (2000 = 100)



Source: Author's computations based on national accounts data from Statistics Iceland and World Bank (2007).

The observation that Iceland was Ghana follows from the fact that, with an average per capita growth rate of 2.6 percent per year 1901-2006, Iceland's per capita GDP increased by a factor of fifteen from 1901 to 2006, plus the fact that, in 2006, Ghana's per capita GDP of 2,640 United States dollars (USD) at PPP was about one-fourteenth of Iceland's per capita GDP of USD 36,560, also at PPP (World Bank 2007). By 1920, Iceland's per capita GDP matched that of today's Lesotho, and, by 1945, Namibia. By 1960, Iceland's per capita GDP had reached the level of today's Botswana. By 2006, Botswana's per capita GDP had climbed to USD 12,250, one third of Iceland's. In other words, Iceland's per capita GDP in 1960 was one third of what it is today, and its annual growth rate of 2.6 percent a year tripled the level of per capita GDP from 1960 to 2006. If Europe could afford to launch significant social welfare reforms in 1880, laying the ground for the modern European welfare state, many

developing countries should be able to do the same today; indeed, some have already started. Social policy matters for growth.

C. Botswana

It would be tempting to conclude this line of reasoning by arguing, or supposing, that countries that are rich in minerals and other natural resources should be particularly well placed to use their resource rents to finance the investments in human and social capital as well as the economic and social reforms necessary for rapid escape from centuries-old poverty. But experience does not support such a happy conclusion to the story (Ascher 1999). True, Botswana has managed its diamonds quite well and used the rents to support rapid growth that has made Botswana the richest country in mainland Africa, having surpassed South Africa a few years ago and being about to surpass also Mauritius in terms of per capita GDP at PPP in constant 2000 international dollars (World Bank 2007). In Botswana, secondary-school enrolments increased from 44 percent in 1991 to 75 percent in 2005 compared with an increase from 55 percent to 89 percent in Mauritius in the same period, and, in South Africa, from 69 percent in 1991 to 93 percent in 2004. According to UNESCO, school life expectancy in 2005 was 12 years in Botswana compared with 13 years in South Africa, 14 years in Mauritius, and 9 years in Ghana.[3] By school life expectancy is meant the total number of years of schooling which a child can expect to receive, assuming that the probability of his or her being enrolled in school at any particular future age is equal to the current enrolment ratio at that age. Between 1991 and 2005, Botswana almost doubled its public expenditure on education from 6 percent of GDP to 11 percent compared with 5 percent in 2005 in Mauritius and South Africa. Similarly, Botswana doubled its public health expenditure from 2 percent of GDP in 2000 to 4 percent in 2004 compared with 2.4 percent in Mauritius and 3.5 percent in South Africa.[4] Unlike Sierra Leone's alluvial diamonds that are easy to mine by shovel and pan and easy to loot, Botswana's kimberlite diamonds lie deep in the ground and can only be mined with large hydraulic shovels and other sophisticated equipment and, therefore, are not very lootable (Olsson 2006; Boschini, Pettersson and Roine 2007). This difference probably helped Botswana succeed while Sierra Leone failed, and so, most likely, did South African involvement – that of De Beers, to be specific – in the

[3] The figures for South Africa and Ghana in the text refer to 2004 and 2006, respectively. School life expectancy represents the expected number of years of schooling that will be completed, including years spent repeating one or more grades. See http://unstats.un.org/unsd/Demographic/products/socind/education.htm.
[4] For more on Botswana, see Acemoglu, Johnson and Robinson (2003).

Botswanian diamond industry. True, with a Gini coefficient of 60 according to the UNDP,[5] Botswana has one of the world's least equal distributions of income and a correspondingly high poverty rate. Even so, by and large, Botswana has enjoyed remarkable economic success accompanied by political stability and a steady advance of democracy that is an exception among the mineral-rich countries to which we now turn.

3. The mineral-rich countries: A quick look

According to the World Bank (2006), real capital in the old, narrow sense of the term constitutes only about one-sixth of total national wealth in low-income countries. Natural capital, including cropland, pastureland, subsoil assets, timber resources, nontimber forest resources and protected areas, constitutes nearly 30 percent of total wealth. The remaining 55 percent of total wealth in low-income countries consists of intangible capital, mostly human capital but also social capital by which is meant the quality of formal and informal institutions. The word capital is used here in a broad sense; its human and social components, in particular, clearly have connotations that reach far beyond real capital in the traditional, narrow sense of the term.[6]

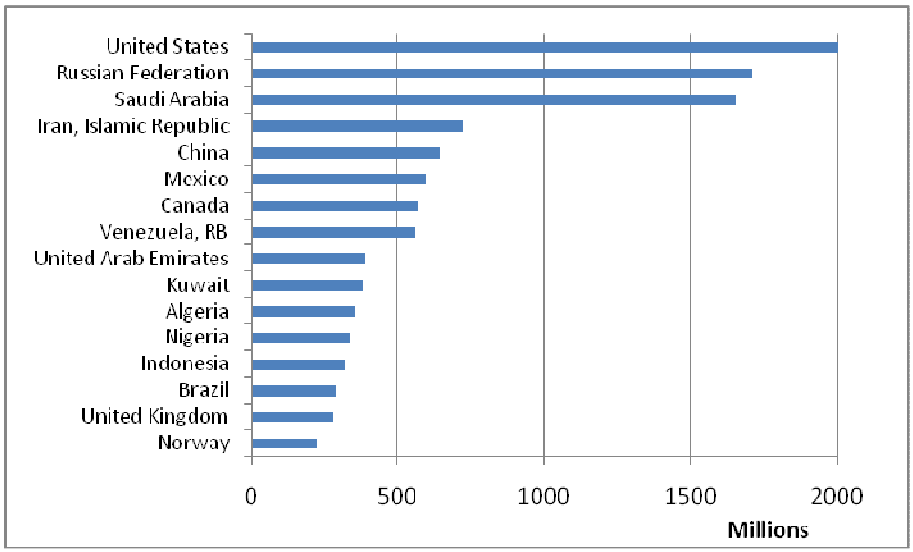
A. The importance of intangible capital

The striking thing about these numbers is the relatively small share of real capital in total wealth and the large share of intangible capital, even in low-income countries. It is also noteworthy that subsoil assets – oil, gas and coal as well as bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin and zinc – comprise less than a fourth of natural capital, and hence a bit less than seven percent of total wealth. In high-income countries, by contrast, intangible capital constitutes 80 percent of total wealth, real capital 17 percent and natural capital two percent. Even so, the high-income OECD countries actually have almost five times as much natural capital as the low-income countries. From this we can see that, in today's world, the macroeconomics of mineral resources needs to be confined to developing countries. Moreover, subsoil assets comprise 40 percent of natural capital in high-income countries compared with 23 percent in low-income countries. Figure 3 shows the 16 countries with the most subsoil assets *in toto* (World Bank 2006). The United States, Canada, the United Kingdom and Norway are the only high-income countries on the list. Figure 4 lists the 27 countries with the most subsoil assets per person (same source). Norway, Canada,

[5] See http://hdrstats.undp.org/indicators/147.html.
[6] This terminology follows common usage in the applied growth literature (see World Bank 2006).

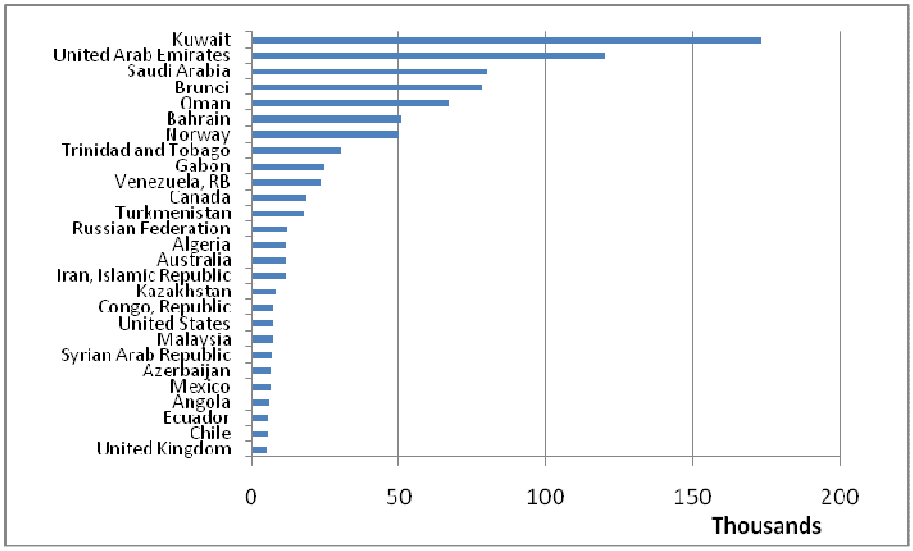
Australia, the United States and the United Kingdom are the only high-income countries among the 27.[7] If we leave out the five industrial countries shown in Figure 4, the average rate of growth of per capita GDP in the remaining 22 countries 1960-2000 was 0.1 percent per year compared with 1.4 percent per capita growth in the 164 countries in the whole sample that will be scrutinized in Sections 4 and 5.

Figure 3. Subsoil assets (USD at 2000 prices and exchange rates)



Source: World Bank (2006).

Figure 4. Subsoil assets per person (USD at 2000 prices and exchange rates)



Source: World Bank (2006).

[7] Botswana is not included in Figures 3 and 4 because the World Bank (2006) still excludes diamonds from its analysis for lack of data as well as for lack of free-market prices.

B. Social, political and economic outcomes

Among the 22 mineral-rich nonindustrial countries listed in Figure 4, there are five high-income countries (four in the Near East and one, Brunei, in the Far East), nine upper middle-income countries and eight lower middle-income countries. Even so, as Table 1 shows, school life expectancy in 2005 in 18 of the 22 countries in Figure 4 for which data are available averaged 11.7 years, a figure that is only slightly above the average for 44 lower middle-income countries (11.4 years) and well below the average for 34 upper middle-income countries (13.5 years).[8] Recall that, by design, school life expectancy is intended as a proxy for educational attainment as human capital built up over time (Barro and Lee 2000). Also, Table 1 shows that fertility is higher in the mineral-rich countries than in either category of middle-income countries. Moreover, public expenditure on health care provision in 2004 in the 22 mineral-rich countries averaged 2.4 percent of GDP, compared with 2.6 percent for lower middle-income countries on average and 3.8 percent of GDP for upper middle-income countries. Taken together, these figures suggest less public expenditure on education and health care and less empowered women in the mineral-rich countries than their level of income might suggest.

Table 1. Mineral-rich countries: Selected indicators

	School life expectancy 2005 (years)	Fertility 1960-2000 (births per woman)	Public health expenditure 2004 (% of GDP)	Demo-cracy 1960-2000 (index)	Corruption 2005 (index)	Investment 1960-2000 (% of GDP)	Per capita growth 1960-2000 (% per year)
Mineral-rich countries	11.7	4.5	2.4	-3.2	3.3	24.3	-0.7
Lower middle-income countries	11.4	3.6	2.6	-1.2	3.0	24.3	3.6
Upper middle-income countries	13.5	2.9	3.8	2.2	4.1	25.9	1.7

Source: Author's computations based on World Bank (2007), UNESCO, Polity IV database and Transparency International. Detailed references are provided in the text.

[8] The number of countries included in this comparison and the others to follow is the maximum number for which requisite data are available.

The data on democracy, an important aspect of social capital, are taken from the *Polity IV Project* at the University of Maryland (Marshall and Jaggers 2001). The democracy index is defined as the difference between an index of democracy that runs from 0 in hard-boiled dictatorships (e.g., Saudi Arabia) to 10 in fully fledged democracies and an index of autocracy that similarly runs from 0 in democracies to 10 in dictatorships. Each of the two components reflects various aspects of democratic rights and freedoms and is an average over the years 1960-2000. The composite democracy index used here spans the range from -10 in Riyadh to 10 in Reykjavík (this is the polity2 index in the Polity IV data base). As Table 1 shows, the 22 mineral-rich countries are less democratic on average than lower middle-income countries and much less democratic than upper middle-income countries. We see, moreover, that corruption is generally more pervasive in the mineral-rich countries than in upper middle-income countries. Further, the mineral-rich countries invest less relative to GDP on average than upper middle-income countries. In view of these patterns, it is perhaps not surprising to see, in the last column of Table 1, that the mineral-rich countries' per capita GDP grew less rapidly than that of other middle income countries in either category.[9] On average, per capita GDP in the nonindustrial mineral-rich countries actually contracted from 1960 to 2000. These patterns – that is, the interactive ways in which different kinds of capital or, equivalently, different inputs drive economic growth – are the subject of the rest of the paper.

4. Cross-country patterns

To understand why the mineral-rich countries have grown less rapidly than the world around them since 1960, we need to look at the ways in which different kinds of capital help sustain economic growth and the factors behind the accumulation of the different kinds of capital. In the spirit of recent research and data compilation at the World Bank (2006), I will resort here to a simple classification of total capital, or total national wealth, by distinguishing among five categories: real capital, human capital, social capital, financial capital and natural capital. The World Bank (2006) lumps human capital and social capital together under the heading of intangible capital, deriving it as a residual by subtracting estimates of produced capital and natural capital in each country from total wealth that is estimated by the perpetual inventory method as the present discounted value of future consumption. As noted before, the word capital is used here is a broad sense in keeping with common usage. In the words of Landes (1998, p. 171), "All models of growth, after all, stress the necessity and power of capital."

[9] For more material on mineral-rich and other primary commodity producing countries, see Radetzki (2008).

A. Five kinds of capital

First, saving and investment are clearly required to build up the real capital that is necessary for growth. In second place, education, training, health care, some forms of social assistance and family planning are needed to build up human capital. The fertility part of the story was described in Section 2: to recapitulate, a planned reduction in fertility can be viewed as a kind of investment in human capital, intended to increase the quality and efficiency of the labour force. Third, if by social capital we mean the quality and strength of the social fabric, including the infrastructural glue that holds the economic system and its institutions together and keeps them in good working order, then several different conceivable determinants or aspects of social capital suggest themselves, including

(i) The absence of corruption in government where by corruption is meant the abuse of public office for private gain. The idea here is that corruption tends to breed inefficiency by creating incentives for stifling regulation of enterprises and for awarding contracts to undeserving builders, and so on, as well as incentives to extort bribes (Bardhan 1997);

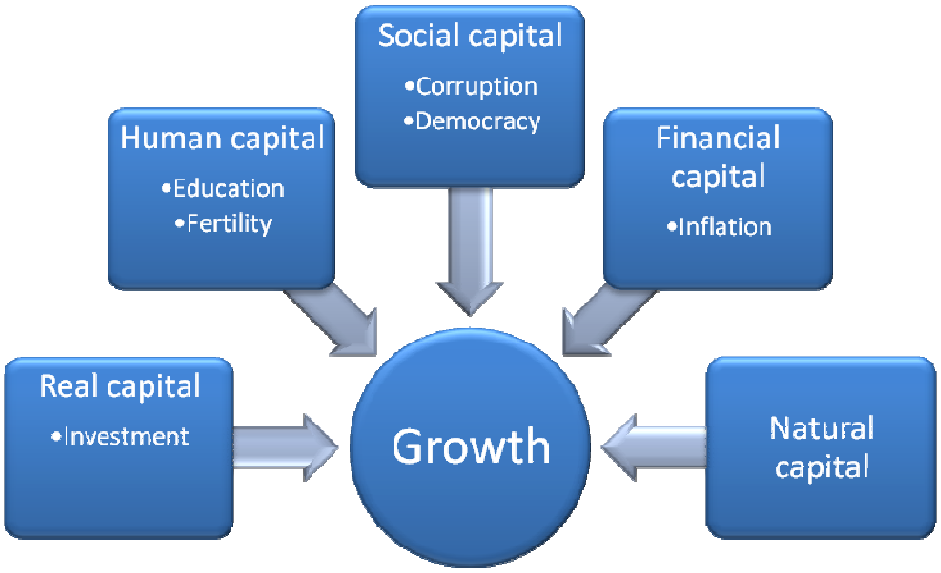
(ii) Like the stamping out of corruption, increased democracy can be viewed as an investment in social capital. The idea here is that political oppression breeds inefficiency by stifling competition in the political arena and by silencing voices that need to be heard, thus reducing the quality of governance and undermining social cohesion;

(iii) Macroeconomic stability with low inflation, besides encouraging the accumulation of financial capital, that is, financial depth, lubricates the wheels of production and exchange, and can thus be thought of as a potentially important ingredient of political and social stability, thereby also boosting economic efficiency and growth.

(iv) A tightly woven social safety net and the social and economic policies that sustain it also strengthen the social fabric and thereby the stock of social capital.

Fourth, low inflation is crucial for the build-up of financial capital – that is, liquidity – that lubricates economic transactions, trade and production. Fifth and last, however, natural capital differs from the preceding four kinds of capital in that at least part of it is not man-made and in that having it in abundance may, without adequate management, be a mixed blessing as suggested by the comparison of the average growth rates of the mineral-rich countries listed in Figure 4 and other middle-income countries in Table 1. Figure 5 describes the above linkages among different kinds of capital and growth. The rest of this section discusses these linkages one by one.

Figure 5. Different kinds of capital and growth



The hypothesis that natural resource wealth, including mineral wealth, tends to be associated with slow growth across countries has received considerable support from a number of recent empirical studies, beginning with Sachs and Warner (1995). The empirical findings have been rather robust, and have triggered a search for possible explanations that suggest that natural capital differs from the other kinds of capital in that too much of it may not be such a good thing. No country was ever held back by the burden of too much human capital[10] or social capital, or financial capital or real capital for that matter (even if excessive investment in real capital contributed to the collapse of communism, but in as much as investment was instrumental in the collapse, the problem was its low quality rather than an excessive quantity). Natural capital seems different in that it tends to unleash forces that may adversely impact the accumulation of other kinds of capital through channels to be discussed below.

B. Resource abundance versus resource dependence

Before going further, it is important to distinguish between natural resource abundance and natural resource dependence. By abundance is meant the amount of natural capital that a country has at its disposal: mineral deposits, oil fields, forests, land and the like. By

[10] Even so, there may be exceptions to this rule such as, for example, the rapid expansion of tertiary education in Nigeria financed by new oil export revenues in the 1970s. Those revenues probably would have made a greater contribution to growth had they been devoted to primary and secondary education instead.

dependence is meant the extent to which the nation in question depends on these natural resources for its livelihood. Some countries with abundant natural resources, for example, Australia, Canada and the United States, outgrew those resources and are no longer especially dependent on them. Hence, the macroeconomics of mineral resources no longer applies to them. Other resource-abundant countries, for example, the Organization of Petroleum Exporting Countries (OPEC), do depend on their resources, some practically for all they have got. Still other countries, say, Chad and Mali, have few resources and yet depend on them for the bulk of their export earnings because they have little else to offer for sale abroad. Others still have few resources and do not depend in any important manner on the little they have, such as, for example, Jordan and Panama. The idea that diversification away from natural resources may be good for long-run growth ought to focus on dependence rather than abundance even if the distinction may in some instances be difficult to make in practice. The working hypothesis here is that excessive dependence on a few natural resources may hurt economic growth, even if an abundance of natural resources, if judiciously managed, may nonetheless be good for growth.

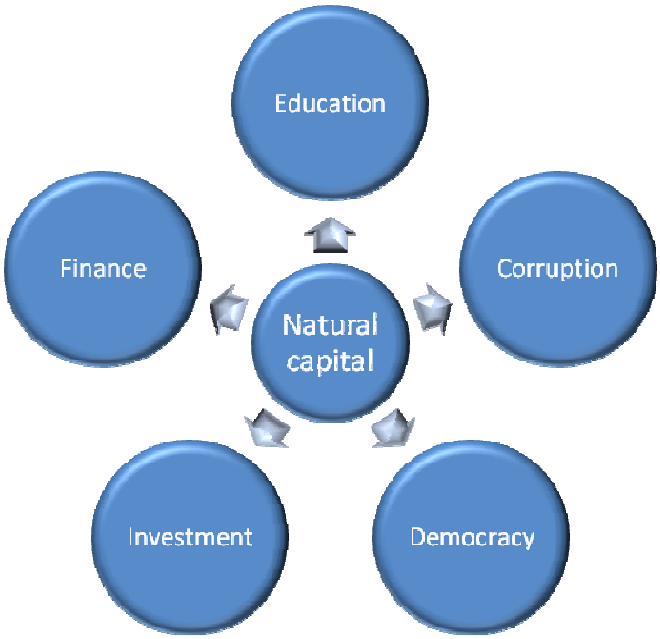
C. Saving, investment and finance

Figure 6 highlights some of the ways in which natural capital influences other kinds of capital or their determinants. First, natural resource dependence may blunt private and public incentives to save and invest and thereby slow down economic growth. Specifically, when the share of output that accrues to the owners of natural resources rises, the demand for capital falls, given constant returns to scale, so that real interest rates also go down and growth subsides (Gylfason and Zoega 2006). In other words, natural capital may crowd out real capital, its quality – that is, efficiency – as well as its quantity. Unproductive investments may seem unproblematic to governments or individuals who are flush with cash thanks to nature's bounty. Most of the mineral-rich developing countries listed in Figure 4 have grown remarkably slowly since 1960 despite a reasonably large volume of investment relative to GDP (Table 1). Moreover, when a substantial part of national wealth is stored in a natural resource, there may be correspondingly less need for financial intermediation to conduct day-to-day transactions. The reason is that consumption can be financed through more rapid depletion of the natural resource and saving can take place through less rapid depletion (or of more rapid renewal if the resource is renewable). In some countries, such as the OPEC states, a significant part of domestic saving is transferred abroad and stored in foreign assets. Domestic financial intermediation then becomes even less important. In contrast, when saving

is piled up at home in the form of real capital, domestic banks and financial markets assume paramount importance. By building bridges between domestic savers and investors, the domestic financial system contributes to a more efficient allocation of capital across sectors and firms. So, if an abundance of, or rather dependence on, natural resource wealth tends to hamper the development of the financial system and thereby to distort the allocation of capital, economic growth may slow down due to the detrimental effect of financial backwardness on saving and investment. Therefore, natural resource dependence tends to retard the development of financial institutions and hence discourage saving, investment and economic growth because investment is usually financed with credit. In short, natural capital may thus crowd out financial capital as well as real capital.

The principle of other people's money may shed further light on the problem. Just as many individuals are more prone to squander an inheritance, not to speak of ill-gotten gains, than their own hard-earned moneys, the owners of natural resources, especially recently discovered resources, sometimes tend to dispose of their new-found wealth in lackadaisical ways. The spending habits of many oil sheiks and sultans are legend. King Faisal of Saudi Arabia (1964-1975) said it well (as quoted by his Oil Minister, Sheik Yamani, in a newspaper interview): "In one generation we went from riding camels to riding Cadillacs. The way we are wasting money, I fear the next generation will be riding camels again."

Figure 6. Natural capital and other kinds of capital



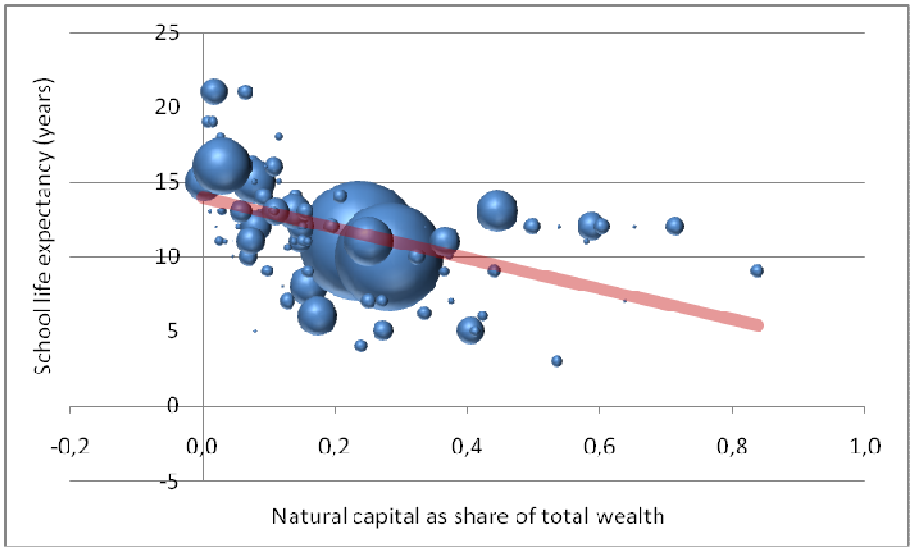
Second, high inflation punishes firms and households for holding money, dries up liquidity and thereby reduces financial maturity or financial depth. The more mature a country's financial markets – that is, the better the markets can serve their core function of channeling household saving into high-quality investment – the higher will be the rate of economic growth, other things being equal. Without enough liquidity to grease the wheels of production and exchange, the economic system begins to stall like engine without oil. Herein lies the importance of money as a medium of exchange. This key role of money helps explain why high inflation hinders financial development and economic growth as well. A producer needs cash in order to be able to keep his engines running, to buy fuel, to replace spare parts that wear out, and so on. That way, cash can be viewed as a factor of production; this is sometimes called working capital. If high inflation makes it too expensive for the producer to hold cash, it also raises the number of dysfunctional engines and other equipment, disrupting production. Through this mechanism, high inflation tends to impair economic efficiency and growth. Surprisingly, this is a rather recent theoretical result because, not long ago, only technological progress was considered capable of driving or influencing long-run growth (Solow 1970). Further, inflation was widely regarded as being always and everywhere a monetary phenomenon, as emphasized by Milton Friedman, so that the possibility that inflation could have something to do with real growth was widely considered remote. The crux of the matter, however, is that inflation is a relative price – the price of money and other nominal assets in terms of real assets – and it is, therefore, fully capable of having real effects. By punishing people and firms for holding cash, high inflation deprives the economy of essential lubrication, and so does financial instability that weakens the ability of banks and other financial institutions to provide needed liquidity to their customers. This is part of the reason why stabilization is good for long-run growth even if a sudden drop in inflation, by reducing profits and weakening the balance sheets of debtors, may result in stagnant output, or worse, in the short run.

D. Education

Third, natural capital may crowd out human capital as well by weakening private and public incentives to promote education. Awash in cash, natural-resource-rich nations may be tempted to underestimate the long-run value of education. Of course, the rent stream from abundant natural resources may enable nations to give a high priority to education – as in Botswana, for instance, where government expenditure on education relative to national income is among the highest in the world. Figure 7 tells the story: school life expectancy (recall Section 2C) is

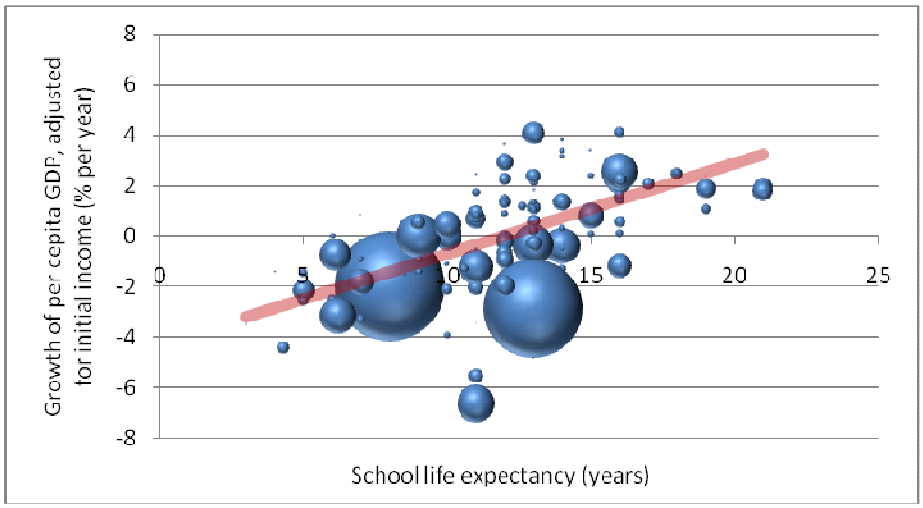
inversely related across countries to natural resource dependence as represented here by the share of natural capital in total wealth. Total national wealth is defined as the sum of natural capital as described above, real capital accumulated through investment in machinery and equipment, and intangible capital that comprises human capital built up through education and other forms of training and social capital intended to reflect the quality of institutions.

Figure 7. Education and natural capital 2000-2005



Source: Author's computations based on data from UNESCO and World Bank (2006).

Figure 8. Economic growth and education 1960-2000



Source: Author's computations based on data from World Bank (2007) and UNESCO.

School life expectancy is available from UNESCO only for 2005, and is taken here to serve as a proxy for the evolution of educational attainment 1960-2000 because the advance of school life expectancy is a gradual process. School life expectancy is closely correlated with the average secondary-school enrolment rate, a commonly used measure of education in empirical growth research: the Spearman rank correlation between the two in our sample of 164 countries, with 13 observations missing, is 0.82. The natural capital share is available only for 2000 (World Bank 2006) as well as for 1994 (World Bank 1997). Now, for the first time, we use the figures for 2000. For each country, the natural capital estimate in the numerator of the ratio is proportional to the predicted future resource rents. Hence, the natural capital share in 2000 is taken as a proxy for the stream of natural resource rents 1960-2000 relative to total national wealth. The slope of the regression line through the scatter of bubbles in Figure 7 suggests that a reduction in natural capital by 10 percent of total wealth from one country to another goes along with an increase in school life expectancy by one year.

There is also evidence that, across countries, public expenditures on education relative to national income, expected years of schooling and school enrolment are all inversely related to natural resource dependence (Gylfason 2001). This is important because more and better education is good for growth and vice versa (Bils and Klenow 2001) as suggested by Figure 8 where per capita growth is measured as in Figure 1 and school life expectancy is measured as in Figure 7. The rank correlation between the two in our sample is 0.69. The slope of the regression line through the scatter of bubbles in Figure 8 suggests that an increase in school life expectancy by three years from one place to another goes along with an increase in per capita growth by more than one percentage point.

E. Corruption

Fourth, resource-rich countries tend to be marred by rent seeking on the part of producers who thus divert resources from more socially fruitful economic activity (Auty 2001). In particular, the combination of abundant natural resource rents, ill-defined property rights, imperfect or missing markets and lax legal structures may have quite destructive consequences. In extreme cases, civil wars break out – Africa's diamond wars, for example – and divert factors of production from socially productive uses and weaken or destroy societal institutions and the rule of law. In other, less extreme cases, the struggle for huge resource rents may lead to a concentration of economic and political power in the hands of elites that, once in power, use the rent to placate their political supporters and secure their hold on power, with stunted or weakened democracy and slow growth as a result. Rent seeking can also take other, more

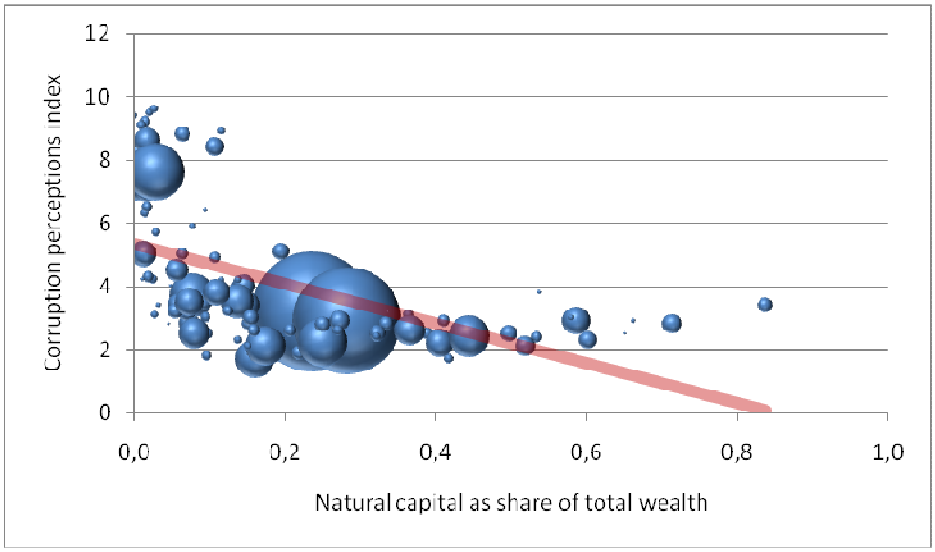
subtle forms. Governments may be tempted to thwart markets by granting favoured enterprises or individuals privileged access to common-property natural resources. The violent struggle for control of Russia's oil and aluminium industry following the collapse of communism is a case in point. Rent-seeking domestic producers often demand protection against foreign competition, for example in the form of restrictions against foreign trade and direct investment, exacerbating the Dutch disease that manifests itself through reduced incentives to produce non-primary goods and services for export which the overvalued currency of the resource-rich country renders uncompetitive at world market prices, reducing trade. Natural capital thus tends to crowd out foreign capital. Just as trade restrictions, by reducing the demand for foreign exchange, contribute to an overvaluation of the currency of the home country, trade liberalization would help reduce the extent of the overvaluation and relieve this particular symptom of the Dutch disease.

Extensive rent seeking – that is, attempts to make money from market distortions – can breed corruption in business and government, thus distorting the allocation of resources and reducing both economic efficiency and social equality. In so far as natural resource dependence involves public allocation of access to scarce common-property resources to private parties without payment, thereby essentially leaving the resource rent up for grabs, it is only to be expected that resource-rich countries may be more susceptible to corruption than others. This is especially likely to happen in the case of point source natural resources (Auty 2001). Further, natural resource abundance may fill people with a false sense of security and lead governments to lose sight of the need for good and growth-friendly economic management, including free trade, bureaucratic efficiency and institutional quality. Incentives to create wealth through sound policies and institutions may wane because of the relatively effortless ability to extract wealth from the soil or the sea. Likewise, corrupt governments that have managed to expropriate valuable natural resources are not likely to be keen to share their political power and with it their access to the natural resource rents with political competitors. This creates a temptation for ruling elites to perpetuate their hold on power by not allowing, or by clamping down on, democracy, thereby reducing efficiency and growth. Manna from heaven can thus be a mixed blessing. Furthermore, natural capital may increase income inequality if natural resource rents tend to be less equally distributed than labour income among the population. Indeed, if this is not so at the time of the resource discovery, then the chief purpose of the ensuing rent-seeking activity is precisely to produce such an outcome. Some of the most resource-rich countries in the world are also among the least democratic and least egalitarian. The readiness of the rest of the world to import oil from, say, Equatorial

Guinea, and thus to buy stolen goods, is an integral part of the problem because a people's right to its natural resources is a human right proclaimed in primary documents of international law and enshrined in many national constitutions (Wenar 2008). Thus, Article 1 of the International Covenant on Civil and Political Rights states that "All people may, for their own ends, freely dispose of their natural wealth and resources …"[11] The foregoing discussion can be summarized by saying that natural capital tends to crowd out social capital through rent seeking, corruption, autocratic tendencies and inequality all of which tend to corrode social capital and reduce growth.

What do the data tell us about these possible linkages? Figure 9 tells the story: corruption in 2005 as measured by Transparency International[12] on a scale from 0 (pervasive corruption) to 10 (squeaky clean) is inversely correlated across countries with the natural capital share. An increase in the corruption perceptions index means less corruption. The Spearman rank correlation between the corruption perceptions index and the natural capital share is -0.74.

Figure 9. Corruption and natural capital 1960-2000



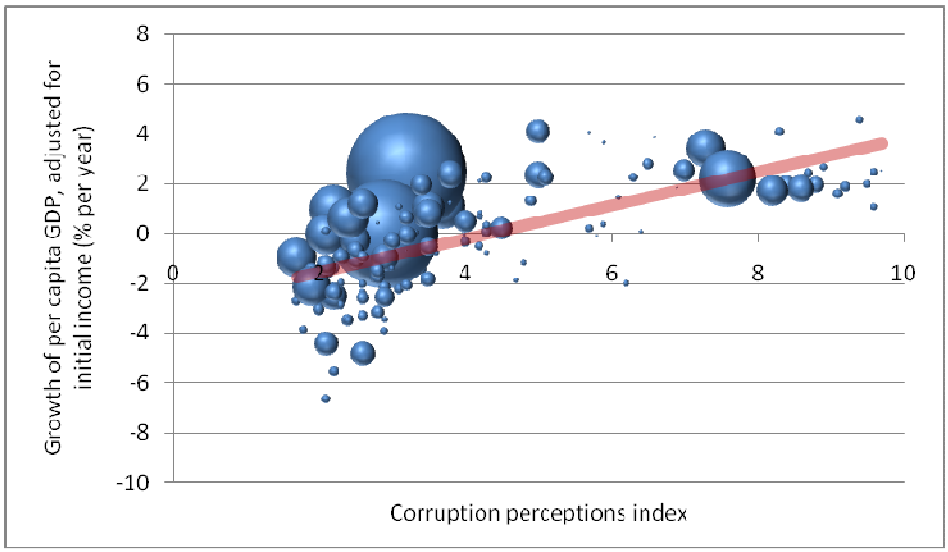
Source: Author's computations based on data from Transparency International and World Bank (2006).

The slope of the regression line through the scatter in Figure 9 suggests an economically as well as statistically significant relationship between corruption and the natural capital share. This is important because corruption is inversely correlated to per capita growth across countries as shown in Figure 10, producing a positively sloped regression line in the figure

[11] The first article of the International Convenant on Economic, Social and Cultural Rights is identical.
[12] See www.transparency.org.

because the corruption perceptions index is decreasing in corruption. The Spearman rank correlation between corruption and growth in Figure 10 is 0.75. This finding accords with the econometric results of Mauro (1995), among others.

Figure 10. Economic growth and corruption 1960-2000



Source: Author's computations based on data from World Bank (2007) and Transparency International.

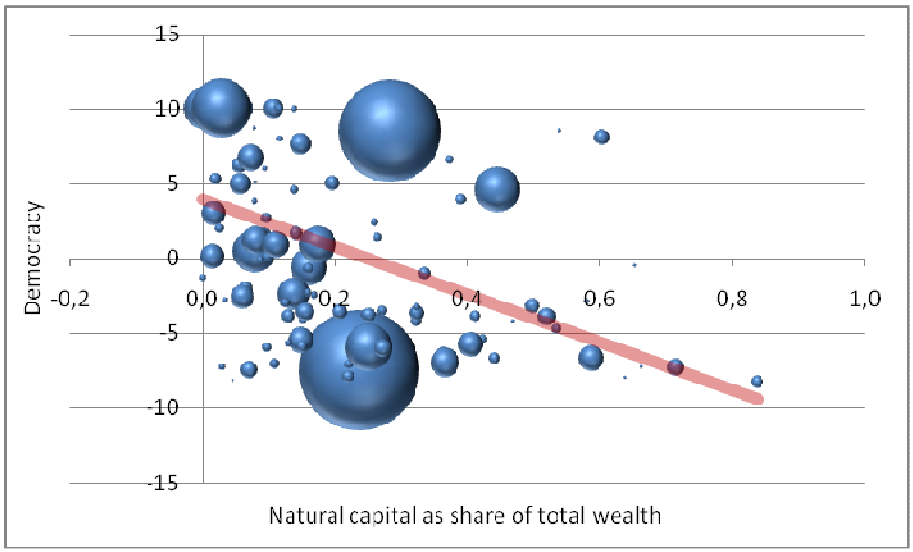
F. Democracy

Figures 11 and 12 tell a similar tale about democracy, natural resources and growth. Figure 11 shows that democracy, measured as in Section 3, varies inversely with the natural capital share across countries. The rank correlation is -0.67. The slope of the regression line through the scatter suggests that a decrease in the natural capital share by 20 percentage points (e.g., from 40 percent of total wealth to 20 percent) goes along with more than a three-point increase in the democracy index, corresponding to the difference between Germany (10) and Turkey (6.7). The pattern shown suggests a direct relationship between economic and political diversification. The figure suggests that liberalization from excessive reliance on natural resources goes along with increased freedom from dependence on narrow political elites and vice versa. Put differently, natural capital tends to crowd out social capital and vice versa. This finding accords with the results of Ross (2001) who reports an adverse effect of oil wealth on democracy.

Figure 12 shows why this finding can have implications for our understanding of economic growth: here we see that, across countries, growth varies directly with democracy, with a rank correlation of 0.51. A six-point increase in the democracy index from one country to another

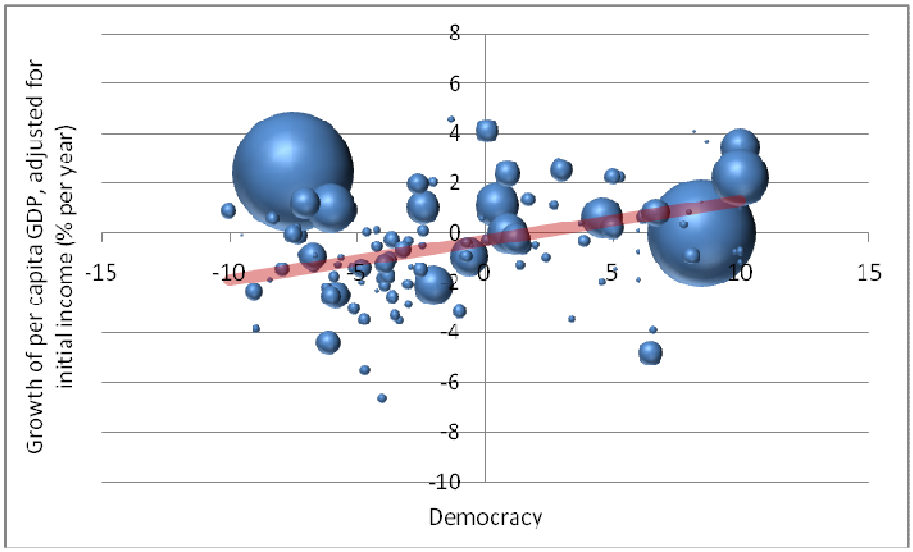
(e.g., from Uruguay with 3.8 to the United Kingdom with 10) is associated with an increase in per capita growth by one percentage point per year. This result differs from the partial correlations that have been reported in some multiple regression analyses where other relevant determinants of growth (investment, education, and so on, as well as initial income) are taken into account, as we will proceed to do in Section 5 with results that accord with Figure 12.

Figure 11. Democracy and natural capital 1960-2000



Source: Author's computations based on data from Polity IV database and World Bank (2006).

Figure 12. Economic growth and democracy 1960-2000



Source: Author's computations based on data from World Bank (2007) and Polity IV database.

For example, Tavares and Wacziarg (2001) suggest that democracy helps growth by improving education and reducing income inequality, but hinders growth by reducing investment and increasing government consumption, with a moderately negative net effect on growth. In his brief literature survey, Drazen (2000, pp. 519-520) detects no sign of a clear effect of democracy on growth. In contrast to these findings, Figure 12 accords with the view that democracy is good for growth and vice versa: there is no visible sign here that democracy stands in the way of economic growth. Political liberty is good for growth because oppression stifles creativity and innovation and thus breeds inefficiency. Yet, Collier and Hoeffler (2009) show that resource rents can either enhance or undermine the contribution of democracy to growth. On the one hand, autocrats may be particularly predatory when empowered by resource rents, while democrats are accountable to the people who can prevent the rents from being captured by greedy minority groups. Except in the United States, natural resources are as a rule common property resources as described by Wenar (2008), so that, by law, the rents accrue in large part to the government. On the other hand, by undermining democratic checks and balances, abundant resource rents tend to unleash patronage politics which can make democratic competition for votes detrimental to growth. As an empirical matter, Collier and Hoeffler (2009) find the former mechanism to be prevalent in industrial countries and the latter mechanism in developing countries.

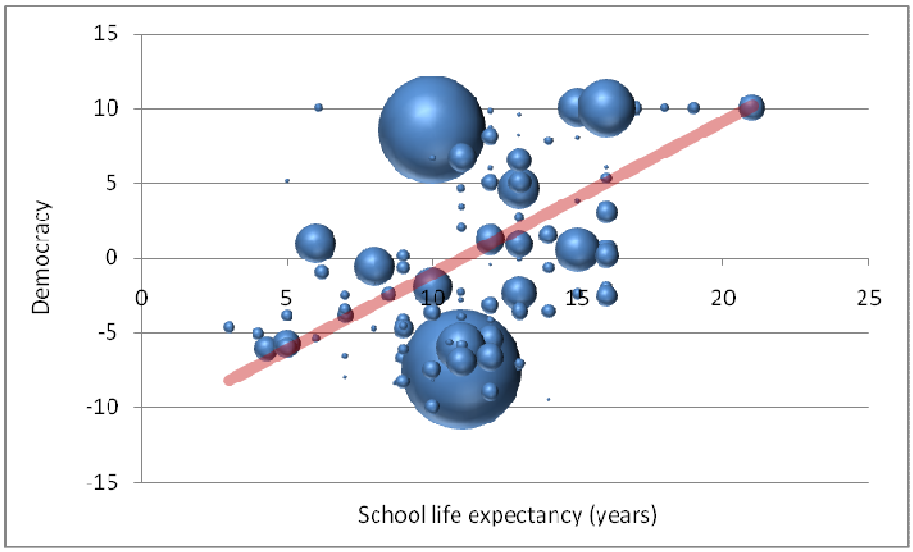
In sum, what we see in Figures 7-12 is a general tendency for the natural capital share to be inversely related to various factors that encourage the build-up of different kinds of capital, including education, honesty and democracy and thus to crowd out human and social capital (for comparable evidence on real capital, see Gylfason and Zoega 2006).

As always, however, there is another way of thinking about democracy and growth: as two simultaneously determined endogenous variables that can move in the same direction or in opposite directions depending on the forces that affect both of them. A natural resource discovery or capture by a violent rebel group with bad economic policy ideas might weaken both democracy and growth. The emergence of a popular democratic leader with unsound economic policies could strengthen democracy and stifle growth, and so on. All combinations are conceivable.

Different kinds of man-made capital tend to go together and to be complementary to one another. For example, human capital and social capital typically go hand in hand because high standards of education call for democracy and vice versa. A poorly educated population – in Haiti, for instance, or in Myanmar – is easier to oppress over long periods than is a well educated and well connected population that knows full well what is amiss. Likewise, a free

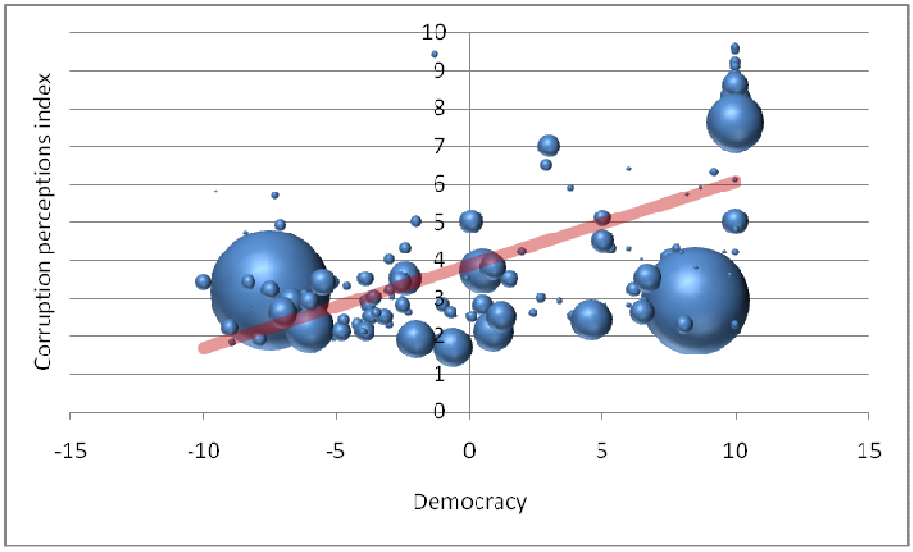
and democratic society is less likely than a dictatorship to tolerate low standards of education. Unsurprisingly, therefore, Figure 13 shows a close cross-country rank correlation (0.62) between democracy and school life expectancy, even if school life expectancy measures education by input rather than by output which is difficult to gauge.

Figure 13. Democracy and education 1960-2000



Source: Author's computations based on data from UNESCO and Polity IV database.

Figure 14. Corruption and democracy 1960-2000



Source: Author's computations based on data from Transparency International and Polity IV database.

The slope of the regression line drawn through the scatter of bubbles in Figure 13 suggests that each additional year of schooling goes along with an increase in democracy by one point, corresponding to the difference between Mauritius (9.6) and India (8.5). Education and democracy are good for one another.

Different aspects of social capital also tend to go hand in hand. Figure 14 suggests that a five-point increase in democracy goes along with a one-point increase in the corruption perceptions index, which means less corruption. The rank correlation between democracy and corruption in the figure is 0.60.[13]

G. Economic and political diversification

The empirical patterns described above suggest that diversification of risk encourages growth through several different channels. Economic diversification is good for growth because it directs economic activity away from excessive reliance on primary production in agriculture or a few natural-resource-based industries, thus facilitating the transfer of labour from low-paying jobs in low-skill-intensive farming or mining to more lucrative jobs in more high-skill-intensive occupations in manufacturing and services. Political diversification encourages growth in a similar manner by redistributing political power from ruling elites to the people, thus in many cases replacing an extended monopoly of often ill-gotten power by democracy and pluralism. The essence of the argument is the same in both cases: diversity is good for growth. Modern mixed economies need a broad base of manufacturing, trade and services to be able to offer the people a steadily improving standard of life. Therefore, they need to find ways of diversifying their economic activity away from once-dominant agriculture that tends to perpetuate poverty and similarly away from too much dependence on a few minerals and other natural resources that tend to stifle or delay the development of modern manufacturing and services. To function well, national economies also need broad political participation and a broad base of power in order to be able to offer the citizenry an efficient and fair way of exercising its political will and civic rights through free assembly, elections and such. Without political democracy, bad governments tend to last too long and do too much damage. The need for diversification is especially urgent in resource-rich countries because they often face a double jeopardy – that is, natural resource wealth that is concentrated in the hands of relatively small groups that seek to preserve their own privileges by standing in the way of both economic and political diversification that would disperse their power and wealth. Rent-

[13] For more on the complementarities of different kinds of capital, see Hall and Soskice (2001).

seekers typically resist reforms – economic diversification as well as democracy – that would redistribute the rents to their rightful owners (see Auty 2001, Ross 2001 and Wenar 2008). Even so, economic diversification does not ensure democracy although it is likely to help, nor does democracy ensure freedom from an often troublesome dependence on natural resources.

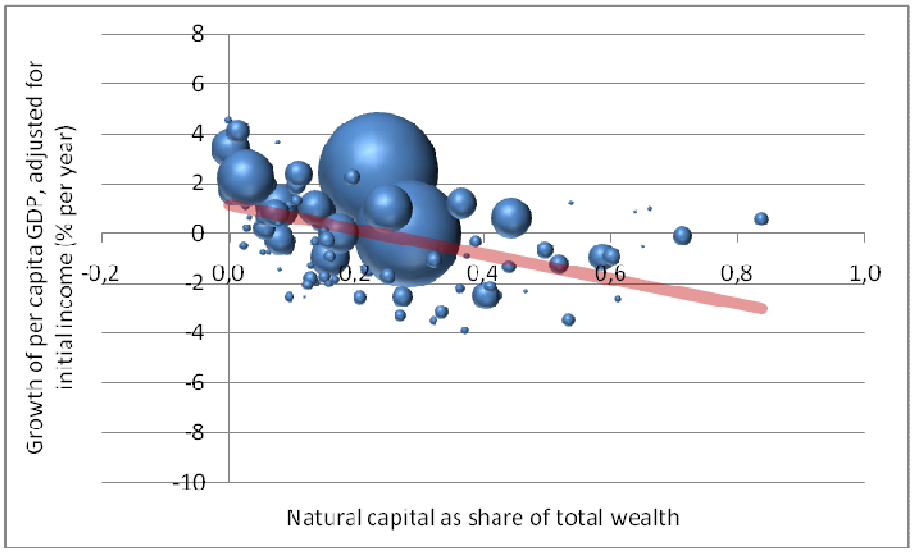
5. Cross-country growth regressions

Against the rough road map laid out in Section 4, let us now look at some cross-sectional empirical evidence covering our 164 countries in the period 1960-2000. The data are all from the World Bank (2006, 2007), with the exception of the data on school life expectancy (UNESCO), corruption (Transparency International) and democracy (Marshall and Jaggers 2001). The sample is twice as large as earlier samples using the World Bank's (1997) earlier measure of natural capital for 1994, until 2006 the sole year for which such data were available. The empirical strategy here is to relate the rate of growth of per capita GDP to its main long-term determinants, that is, to measures of investment in different kinds of capital as well as to initial income to capture the conditional convergence effect. Specifically, the aim is to look for statistical evidence of cross-country linkages among resource dependence and economic growth in the context of the recent empirical growth literature to ascertain that the bivariate correlations (or, more accurately, trivariate correlations because per capita growth in Figures 1, 8, 10 and 12 is adjusted for initial income) reported in Section 4 accord with the results of multivariate regression analysis of the same data where the main determinants of growth identified in earlier work are considered together.

We begin by making a quick spot check to allow the data on growth and the natural capital share to speak for themselves. Figure 15 shows the relationship between average annual per capita growth of GDP in 1960-2000, adjusted as before for initial income, and the share of natural capital in total wealth, our proxy for natural resource dependence. A decrease in the natural capital share by 20 percent of total wealth is associated with an increase in per capita growth by one percentage point per year, a significant relationship in an economic sense even if at this stage nothing is said about cause and effect. The Spearman rank correlation is -0.67 and highly significant in a statistical sense. This result is not surprising in view of the inverse correlations between the natural capital shares and several potential determinants of the accumulation of human and social capital documented in Section 4. In Figure 16, for comparison, we see the cross-sectional relationship between per capita growth and the share of subsoil assets in total wealth. The Spearman rank correlation is now only -0.10, but

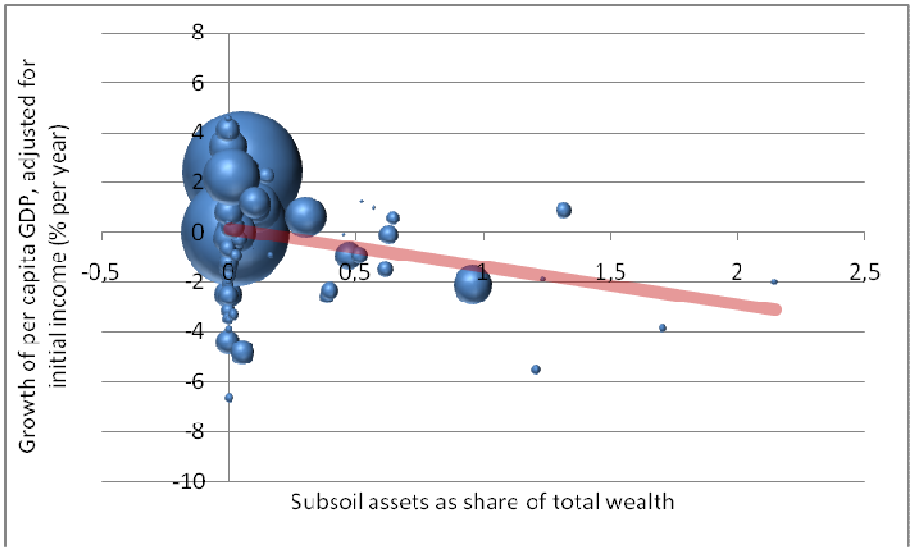
remains statistically significant because the sample is large.

Figure 15. Economic growth and natural capital 1960-2000



Source: Author's computations based on data from World Bank (2006, 2007).

Figure 16. Economic growth and subsoil assets 1960-2000



Source: Author's computations based on data from World Bank (2006, 2007).

A. Is natural capital a robust determinant of growth?

We now take the next step and estimate a series of growth regressions for the same 164 countries as before, again during 1960-2000. The strategy here is to regress the rate of growth

of per capita GDP during this 40-year period on the share of natural capital in total wealth, defined as in Figure 15, and then to add to the regression other potential determinants of growth representing aspects of other types of capital in order to assess the robustness of the initial result – that is, to see if natural capital survives the introduction of additional explanatory variables that are commonly used in empirical growth research. As we add more independent variables, the number of observations drops gradually from 164 to 99 due to missing data.

Table 2 presents the resulting sequence of regressions. Model 1 shows a statistically significant inverse relationship between per capita growth and the logarithm of initial income (i.e., in 1960). This relationship reflects conditional convergence – the idea, as noted before, that rich countries grow less rapidly than poor ones because the rich have already exploited more of the growth opportunities available to them, by sending more young people to school, for instance. Initial income is defined as PPP-adjusted per capita gross national income (GNI) in 2000 divided by an appropriate growth factor to ensure consistency between our income measures in 1960 and 2000 and our measures of economic growth between those years; more on this below. Here we see that the coefficient on initial income is significantly negative as expected. In Model 2, we add the natural capital share in total wealth, our proxy for natural resource dependence, to the regression. As in Figure 15, an increase in the natural capital share reduces growth for given initial income. When natural capital per person, our proxy for natural resource abundance, is added to the regression in Model 3, we see that natural resource dependence continues to hurt growth as hypothesized, even if natural resource abundance has a positive effect on growth. Next, in Model 4, we add democracy as a representative of social capital to the regression. We see that democracy is good for growth in accordance with Figure 12 and all the preceding variables survive. If a dummy variable that equals one in democracies (i.e., in countries with a positive democracy index) and zero elsewhere is used instead of the democracy index itself, the results (not shown) suggest that democracies grow significantly more rapidly than the rest, or by 0.6 percentage points per year on average. For comparison, the median per capita growth rate in our sample is 1.5 percent per year. In Model 5, we add the logarithm of the share of gross domestic investment in GDP and find that it makes a significant contribution to growth as expected, even if no attempt has been made to adjust the investment figures for quality; the logarithmic formulation is intended to capture decreasing returns to investment and fits the data slightly better than the more commonly used linear formulation. In Model 6, we then proceed to add education, represented by the logarithm of the school life expectancy variable. Like

investment, education stimulates growth without displacing any of the variables inherited from the preceding models. This result accords with Figure 8. At last, in Model 7, we enter fertility measured by the number of births per woman into the regression to see if it matters for growth as suggested by the neoclassical growth model as well as by our hypothesis that reduced fertility can be regarded as an alternative form of investment in human capital. We see that increased fertility growth reduces economic growth as expected, without reducing the statistical significance of the explanatory variables already included in the regression. Specifically, a reduction in fertility from five births per woman to two births per woman reduces annual per capita growth by one percentage point. This suggests a significant population drag on growth or, alternatively, an additional channel through which the build-up of human capital aids growth.

The bottom line of Table 1 shows how the adjusted R^2 rises gradually as more explanatory variables are added to the growth regression and ultimately reaches 0.64, indicating that Model 7 explains almost two thirds of the cross-country variations in the long-run rate of growth of per capita output.[14] Clearly, Model 7 does not tell the full story of the determinants of growth; no model does, not yet, and perhaps never will. For example, despite broad agreement among economists on theoretical grounds that foreign trade is good for growth, indicators of openness to trade often fail to register as significant determinants of growth in econometric work. Too many explanatory variables in a single growth equation tend to get in each other's way. Presumably, this happens when two or more explanatory variables compete to explain the same source of efficiency gains. This is why there is not room for education and health variables side by side in the same growth equation, or for corruption, inequality and democracy side by side.

Even so, it may be worthwhile to report a couple of extensions of Model 7 in Table 2. First, when inflation – or, precisely, the inflation distortion defined as the annual inflation rate divided by one plus the inflation rate – is added to the growth model on the grounds that high inflation erodes the financial capital stock and reduces efficiency, the inflation variable has the expected negative effect on growth (not shown). A decrease in inflation from 50 percent a year to zero increases per capita growth by almost one percentage point as in Gylfason and Herbertsson (2001), but here the presence of inflation in the model weakens the effects of resource abundance, investment and democracy on growth. If, however, the democracy dummy is used instead of the democracy index, the dummy easily survives the introduction of

[14] The drop in the adjusted R^2 when democracy is added to the regression in Model 4 stems from the decrease in the number of observations.

the inflation variable. Second, when an interaction term involving the multiple of the natural capital share and the democracy dummy is added to Model 7 in the spirit of Mehlum, Moene and Torvik (2006), we find that the negative effect of natural resource dependence on growth is significantly more negative in democracies than under authoritarian regimes and that the positive effect of democracy on growth is smaller (and in a few extreme cases turns negative) in countries with a high share of natural capital in national wealth (again, not shown). These results conform to those of Collier and Hoeffler (2009), but differ somewhat from those of Mehlum, Moene and Torvik (2006).

Table 2. Regression results on natural capital and economic growth

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Initial income	-0.74 (5.2)	-0.49 (3.1)	-0.96 (5.3)	-1.07 (5.2)	-1.24 (7.0)	-1.72 (10.2)	-1.875 (10.7)	0.262 (3.8)
Natural capital share		-0.04 (5.3)	-0.06 (7.1)	-0.05 (4.7)	-0.04 (5.3)	-0.02 (3.2)	-0.022 (2.9)	-0.009 (2.9)
Natural capital per person			0.10 (4.5)	0.08 (3.7)	0.06 (3.3)	0.04 (2.2)	0.040 (2.4)	0.016 (2.4)
Democracy				0.07 (2.2)	0.07 (2.7)	0.08 (3.2)	0.061 (2.4)	0.024 (2.4)
Investment rate (log)					2.92 (6.8)	1.39 (3.0)	0.936 (1.9)	0.359 (1.9)
School life expectancy (log)						3.01 (6.4)	2.470 (4.9)	0.978 (4.9)
Fertility							-0.309 (2.5)	-0.121 (2.5)
Countries	164	125	124	113	113	99	99	99
Adjusted R^2	0.14	0.18	0.29	0.27	0.48	0.61	0.64	0.88

Note: In Models 1-7, the dependent variable is the average rate of growth of per capita GDP 1960-2000. In Model 8, the dependent variable is the logarithm of per capita GNI at PPP in constant 2000 US dollars. t-values are shown within parentheses. Estimation method: Ordinary least squares.

The results from Model 7 accord reasonably well with a number of recent empirical growth studies. In Model 7, the coefficient on initial income suggests a conditional convergence speed of almost two percent per year. This is not significantly below the two percent to three percent range typically reported in econometric growth research. The coefficient on the investment rate suggests that an increase in investment by 50 percent (e.g., from 16 percent of GDP to 24 percent) increases annual per capita growth by half a percentage point, a strong but fairly typical result in those growth studies that report a statistically significant effect of investment on growth (rather than leaving investment out on the grounds that it is an endogenous variable like growth). The coefficient on the education variable in Model 7 means that an increase in school life expectancy by 20 percent (e.g., from 10 years to 12 years) increases per capita growth by half a percentage point. Last but not least, the coefficient on the natural resource dependence variable suggests that an increase in the share of natural capital in total wealth by 25 percentage points reduces per capita growth by half a percentage point, even if natural resource abundance may at the same time be good for growth. This effect is qualitatively the same but quantitatively weaker than the effect of the natural capital share on growth based on the World Bank's (1997) estimate of natural capital in 1994 for a significantly smaller sample of countries (Gylfason 2007). Beginning with Sachs and Warner (1995), several recent studies have reported a broadly similar conclusion about the effect of natural resource dependence on growth, based on various measures of the natural resource intensity variable.

B. Income levels versus rates of growth

In Model 8, the dependent variable is GNI per capita at PPP in 2000 rather than the annual average growth rate of per capita GDP from 1960 to 2000. By construction, the estimation results from Model 8 are identical to those from Model 7 except (i) the coefficient on initial income in Model 8 equals one minus 0.4 times the coefficient on initial income in Model 7 and (ii) the remaining coefficients in Model 8 equal 0.4 times the corresponding coefficients in Model 7. The coefficient 0.4 equals the number of years (40) in the sample divided by 100. The test of conditional convergence in Model 8 is that the coefficient on initial income be significantly less than one, which is easily met. Side by side, Models 7 and 8 demonstrate that it makes no difference whether the contributions of various determinants of growth are assessed in a growth model such as Model 7 or in a corresponding model expressed in terms of the level of income at the end of the sample period such as Model 8 as long as the data

satisfy the fundamental requirement that per capita income in the final year equals initial income multiplied by one plus the annual average growth rate *g* raised to a power that equals the number of years in the sample – that is, $y_{2000} = y_{1960}(1+g)^{40}$.

Model 8 expresses the growth of per capita GDP from 1960 to 2000 in terms of the level of per capita output in 2000 resulting from past growth in the same way as we argued that the end-of-period (actually, 2005) value of school life expectancy reflects past investments in human capital through schooling, thereby permitting us to circumnavigate the interpretation of Model 7 as a description of a retroactive relationship between growth and schooling. Model 8 can thus be interpreted as a description of the dependence of the per capita level of output in 2000 on the contemporaneous values of school life expectancy as well as the natural capital share plus the average values of the other independent variables over the sample period.

C. Abundance versus dependence, again

In sum, we have seen that natural capital influences economic growth in two ways. On the one hand, an increase in the share of natural capital in total wealth reduces economic growth. On the other hand, an increase in natural capital per person stimulates growth. Because natural capital per person equals, by definition, the multiple of the share of natural capital in total wealth and wealth per person, Model 7 in Table 2 suggests that the total effect of an increase in the natural capital share on economic growth is -0.02 plus 0.04 times wealth per person (in hundreds of thousands of US dollars). Therefore, the total effect of an increase in the natural capital share on growth declines with wealth per person but remains negative as long as total per capita wealth is below USD 50,000 (= $0.02/0.04\times10^5$). For comparison, the median total per capita wealth in our sample is USD 35,000. In the sample, 104 countries have total wealth below USD 50,000 and 60 countries have more than that. This means that an increase in the natural capital share tends to reduce growth in developing countries, but may well increase growth in industrial countries. With many more developing countries in the sample than before, when natural capital estimates for 1994 were available for only 92 countries (Gylfason 2007), the cut-off point has been reduced from USD 200,000 to USD 50,000, but the result remains that the net effect of an increase in the natural capital share on growth is negative in two thirds of the countries in the sample. These results can be supplemented by tracing the additional effects of increased natural capital on real capital via blunted incentives to save and invest; on human capital through neglect of education; on social capital via rent seeking, civil and political oppression, corruption and so forth, as well

as on financial capital through failure to develop institutions and on foreign capital through protectionism along the lines discussed in Section 2.

D. Decomposition of growth

Let us now make an experiment. Suppose your country's growth performance is correctly described by Model 7 in Table 2 and that five of the determinants of growth listed – the natural capital share, democracy, investment, school life expectancy, and fertility – move in a growth-friendly direction by one standard deviation each, while initial income and natural capital per person remain unchanged. Table 3 shows that such a change would increase your country's per capita growth by one percentage point and, moreover, shows the individual contributions of the five separate determinants of growth to this outcome. For comparison, the median per capita growth rate in our sample from 1960 to 2000 is 1.5 percent per year. It is striking that the human capital variables – education and fertility – account for more than a half of the increase in growth by one percentage point, while investment in real capital accounts for only ten percent. Natural resource dependence and democracy account for the remaining third, in roughly equal proportions. We can conclude that the natural capital share makes an economically as well as statistically significant contribution to economic growth.

Table 3. Decomposition of per capita growth (in percent)

Per capita growth	0.99
Natural capital share (19.0)	0.17
Democracy (6.4)	0.15
Investment (log, 0.29)	0.10
School life expectancy (log, 0.35)	0.34
Fertility (1.8)	0.22

Note: The table shows the contributions to per capita growth per year of a decrease in the natural capital share and fertility and an increase in democracy, investment and school life expectancy by one standard deviation each variable. Standard deviations are shown within parentheses.

E. Subsoil assets versus natural capital

Table 4 shows the results of using subsoil assets instead of natural capital in the regression analysis, thus excluding cropland, pastureland, timber resources, non-timber forest resources and protected areas from consideration to sharpen the focus on mineral assets. The patterns that emerge are essentially the same as before except the investment effect on growth vanishes in Model 7. In Table 4, Model 7 suggests that the total effect of an increase in the share of subsoil asset in total wealth on economic growth is -0.01 plus 0.04 times wealth per person (in hundreds of thousands of US dollars). Therefore, the total effect of an increase in the subsoil asset share on growth declines with wealth per person but remains negative as long as total per capita wealth is below USD 25,000 (= $0.01/0.04\times 10^5$) which is true of one half of the countries in our sample, 82 countries.

Table 4. Regression results on subsoil assets and economic growth

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Initial income	-0.74 (5.2)	-0.69 (4.6)	-0.74 (4.7)	-1.26 (7.5)	-1.47 (9.6)	-2.03 (14.4)	-2.241 (14.5)	0.103 (1.7)
Subsoil asset share		-0.02 (2.9)	-0.02 (3.1)	-0.01 (1.4)	-0.02 (3.1)	-0.01 (2.8)	-0.010 (2.2)	-0.004 (2.3)
Subsoil assets per person			0.01 (1.1)	0.03 (2.4)	0.04 (3.8)	0.04 (5.1)	0.043 (5.5)	0.017 (5.5)
Democracy				0.19 (6.3)	0.17 (6.6)	0.12 (5.1)	0.093 (3.9)	0.037 (3.9)
Investment rate (log)					3.08 (5.9)	0.97 (1.9)	0.450 (0.9)	0.159 (0.8)
School life expectancy (log)						4.09 (8.9)	3.406 (6.8)	1.364 (6.8)
Fertility							-0.379 (2.9)	-0.151 (2.9)
Countries	164	153	153	139	139	123	123	123
Adjusted R^2	0.14	0.17	0.17	0.34	0.48	0.68	0.69	0.83

Note: See note below Table 2.

The specification with natural capital broadly defined as in Table 2 is more relevant to the task at hand, however, because it incorporates the effects of other types of natural capital – timber, for example – that raise many of the same concerns as mineral wealth.

F. Education and democracy as endogenous variables

In empirical growth economics, it is sometimes said, everything depends upon everything else and nothing is exogenous except initial income. The exploration of all possible interactions among the determinants of growth listed in Table 2 and the econometric endogeneity issues involved would take us too far afield, so let us briefly confine our attention to the possibility that private as well as public decisions about education and collective decisions about political regimes respond to economic forces.

Table 5. Regression results on natural capital and education

	Model 1	Model 2	Model 3	Model 4
Initial income	1.79 (8.6)	2.29 (9.1)	1.76 (6.1)	0.656 (2.2)
Natural capital share		-0.06 (4.1)	-0.07 (5.3)	-0.044 (3.4)
Natural capital per person			0.12 (3.3)	0.079 (2.6)
Fertility				-1.105 (6.5)
Countries	142	108	108	108
Adjusted R^2	0.34	0.58	0.62	0.72

Note: The dependent variable is school life expectancy. t-values are shown within parentheses. Estimation method: Ordinary least squares.

Table 5 shows the results of regressing school life expectancy on initial income, the two natural capital variables and fertility. We see, first, that initial income exerts a significant positive effect on education; the coefficient 0.66 in Model 4 means that each doubling of initial per capita income goes along with an extension of school life expectancy by almost half a year (because the natural logarithm of 2 is 0.7). Second, resource dependence hurts education while resource abundance helps education. Third, education is inversely related to

fertility: a reduction in fertility by one birth per woman goes along with an increase in school life expectancy by over a year from one country to the next. This finding accords with the discussion in Section 2A of fertility, education and economic growth.

A similar pattern emerges when democracy is regressed on initial income, the two natural capital variables and corruption. In Table 6, initial income has a positive effect on democracy.[15] The size of the coefficient 2.05 in Model 4 means that each doubling of initial per capita income goes along with an increase of 1.4 in the democracy index (because, again, the natural logarithm of 2 is 0.7). Second, resource dependence weakens democracy and resource abundance strengthens democracy. Third, democracy is inversely related to corruption: a reduction in corruption (i.e., an increase in the corruption perceptions index) by five points, spanning more than half the scale from one to ten, goes along with an increase in democracy by four points from one country to the next, other things being equal. This finding accords with the correlation exhibited in Figure 14.

Table 6. Regression results on natural capital and democracy

	Model 1	Model 2	Model 3	Model 4
Initial income	2.61 (6.2)	3.57 (7.6)	2.73 (4.9)	2.051 (3.4)
Natural capital share		-0.08 (3.3)	-0.11 (4.2)	-0.076 (2.5)
Natural capital per person			0.17 (2.7)	0.112 (1.7)
Corruption				0.786 (2.7)
Countries	143	113	113	106
Adjusted R^2	0.21	0.49	0.52	0.53

Note: The dependent variable is the index of democracy. t-values are shown within parentheses. Estimation method: Ordinary least squares.

When the models shown in Tables 2, 5 and 6 are estimated as a system by the seemingly uncorrelated regression method, the coefficient estimates obtained are quite similar to those reported in Table 2, and are not reported here. By first regressing education and democracy on

[15] The Lipset hypothesis, by contrast, is that democracy is conducive to high incomes; see Lipset (1959).

exogenous variables in Tables 5 and 6, education and democracy by themselves become exogenous in the estimation of the growth equation in the three-equation system. If the system so estimated is correctly specified, the results suggest that the endogeneity biases in the ordinary-least-squares estimates shown in Table 1 are immaterial.

6. Concluding remarks

This paper has stressed the importance of social development and social policies to economic growth around the world as well as the interactions among aspects of social capital, human capital and natural capital in the growth process. The thrust of the argument has been that recent empirical evidence suggests that excessive dependence on natural capital, including oil and other mineral resources, may blunt incentives to build up other types of capital that are essential to sustained growth over long periods. In this sense, natural resources, if not well managed, may be a mixed blessing. New empirical evidence based on fresh natural capital data from the World Bank was presented in support of this view. The upshot of the argument is that (a) economic diversification encourages growth by directing economic activity away from excessive reliance on primary production and facilitating the transfer of labour from low-paying jobs in low-skill-intensive farming or mining to more lucrative jobs in more high-skill-intensive occupations in manufacturing and services; and (b) political diversification is likewise good for growth because it redistributes political power from narrowly based ruling elites to the people, thus in many cases replacing an extended monopoly of often ill-gotten power by democracy and pluralism. Diversity is good for growth.

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