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# Challenges and Opportunities for Resource Rich Economies

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# *Challenges and Opportunities for Resource Rich Economies*

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## Abstract

The political economy of resource rich countries is surveyed. The empirical evidence suggests that countries with a large share of primary exports in GNP have bad growth records and high inequality, especially if the quality of institutions and the rule of law are bad. The economic argument that a resource bonanza induces appreciation of the real exchange rate and a decline of non-resource export sectors may have some relevance. More important, a resource boom reinforces rent grabbing, especially if institutions are bad, and keeps in place bad policies. Optimal resource management may make use of the Hotelling rule and the Hartwick rule. However, a recent World Bank study suggests that resource rich economies squander their natural resource wealth and more often have negative genuine saving rates. Still, countries such as Botswana, Canada, Australia and Norway suggest it is possible to escape the resource curse. Some practical suggestions for a better management of natural resources are offered.

## Keywords

Resource curse, cross-country and panel evidence, growth record, Dutch disease, dependent economy, real exchange rate, debt overhang, corruption, rule of law, institutions, optimal resource depletion, Hotelling rule, genuine saving, Hartwick rule, natural resource wealth management, sustainable development, transparency, resource fund, resource dividend

**JEL code:** C12, C13, E01, F43, K42, O41, Q3

## 1. Introduction*

Many recognise the opportunities natural resources provide for economic growth and development and see the challenge of ensuring that natural resource wealth leads to sustained economic growth and development. The interesting question is why some resource rich economies, such as Botswana, Canada, Australia and Norway, are more successful while other resource-rich economies perform badly despite their immense natural wealth. Is it because the resource boom induces an appreciation of the real exchange rate and makes non-resource sectors less competitive? Are learning by doing and other spill-over effects strong enough in those non-resource traded sectors to warrant government intervention? Or do the riches of a resource bonanza induce a shift from profit-making entrepreneurship towards wasteful rent seeking? How much of this depends on the quality of institutions and the rule of law? Is it really possible that natural resource wealth is squandered by corruption and rent grabbing at the expense of widespread inequality and poverty? Does a resource boom induce governments to put unsustainable policies in place and maintain bad policies for too long? To shed lights on these important empirical questions one needs to carefully examine case studies of resource rich economies and econometrically investigate the best cross-country and panel data evidence. It then becomes clear that the resource rich economies have a wide variety of experiences.

An important issue is whether economic theory offers useful insights into the optimal management of natural resources. One strand of literature focuses on arbitrage arguments and the Hotelling rule. This requires that the price of natural resource should grow at the world rate of interest and that under some conditions the rate of depletion should equal the demand elasticity times the world rate of interest. Another line of theoretical research investigates the optimality of the Hartwick rule, which demands that the proceeds of natural resource revenues are reinvested in productive assets. The World Bank has calculated that many resource- abundant economies do not follow the Hartwick rule. In fact, many of these countries have negative genuine saving rates and become poorer each year. This highlights the important policy question of what resource rich economies can do to avoid the resource curse. Apart from the obvious suggestions of having good institutions and a reliable rule of law, it may help to improve transparency about how much resource revenues are generated and what happens to these revenues. Alternatively, it may help to put the revenues in an independent fund in order to make sure that resource wealth is eventually transformed into other forms of wealth (e.g., buildings, roads, machines, human capital) as saving is an essential part of economic development. The problem is that such a fund may be raided in countries with poor institutions. Perhaps, it is therefore best to distribute the resource revenues to the public at large in the form of a resource dividend.

To obtain a better understanding of the analysis of resource rich economies, this paper surveys the relevant literature and offers some suggestions for policy. Section 2 surveys the empirical evidence for the so-called curse of resource rich economies. The experience of some selected countries and the extensive literature on the effects of resource abundance on the prospects for economic growth suggests that this curse is particularly severe for countries with weak institutions, poor legal systems and little democracy. The recent World Bank evidence on the contribution of natural resources to national wealth also points to a resource curse. Section 3 discusses the various economic and political explanations put forward to explain the often disappointing experiences of resource rich economies. Section 4 discusses the optimal management of exhaustible resources leading to normative guides such as the Hotelling rule and the Hartwick rule. Recent World Bank estimates of genuine saving are discussed. Some insight is also given on the implications for resource rich economies if the Hartwick rule were implemented in practice. The implications for the Hartwick rule in the global rule are also

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discussed. Section 5 offers some practical remedies for avoiding the natural resource curse. Section 6 concludes.

## 2. Evidence for the natural resource curse

Although there are resource rich countries that benefit from their natural wealth, the economies of many other resource-rich countries are in a terrible state. Natural resource wealth may harm economic performance and make citizens worse off. We first discuss some well-known examples of countries whose abundance of natural resources have gone together with bad macroeconomic performance and growing inequality among its citizens as well as some countries that have benefited from their natural resource wealth. Subsequently, we discuss cross-country evidence for a natural resource curse.

### *2.1. Experiences of some resource rich countries*

Accounts of the curse of natural resources are available for many countries (e.g., Gelb, 1988; Karl, 1997ab; Wood, 1999; Auty, 2001b). The most dramatic example is perhaps Nigeria (Bevan, Collier and Gunning, 1999; Sala-i-Martin and Subramanian, 2003). Nigeria has since 1965 been a major oil exporter. Oil revenues per capita increased from US$33 in 1965 to US$325 in 2000. Still, income per capita in Nigeria has stagnated at around US$1100 in PPP terms since its independence in 1960 despite huge oil wealth, putting Nigeria among the 15 poorest countries in the world. Between 1970 and 2000 the percentage of the population having to survive on less than US$1 per day increased from 26 percent to almost 70 percent. In 1970 the top 2 percent had the same income as the bottom 17 percent, but in 2000 the top 2 percent has the same income as the bottom 55 percent. Clearly, huge oil exports have not benefited the average Nigerian. Although Nigeria has since independence experienced substantial investment in physical capital at 6.7 percent per year, it has suffered a declining TFP at an average of 1.2 percent per year. Not surprisingly, capacity utilisation of manufacturing now hovers around a third. Two thirds of capacity often owned by the government thus goes to waste. Successive military dictatorships have plundered oil wealth and Nigeria is known for its stories about transfers of large amounts of undisclosed wealth. Oil wealth has fundamentally altered politics and governance in Nigeria. It is hard to maintain that the standard Dutch disease story of a worsening competitiveness of the non-oil export sector explains the miserable economic performance of Nigeria. Instead, exchange rate policy seemed to be driven by rent and fiscal imperatives and relative price movements were almost a by-product of the resource boom (Sala-i-Martin and Subramanian, 2003).

Other oil exporters such as Iran, Venezuela, Libya, Iraq and Kuwait and Quatar experienced negative growth rates during the last few decades. Indeed, the OPEC as a whole saw a decline in GNP per capita while other comparable countries in terms of GNP per capita enjoyed growth. The gold price boom in the 1970's together with increased barriers to technological adoption helps to explain the de-industrialisation and disappointing growth experience of South Africa (Stokke, 2005). The disruption of the 'air bridge' from 1994 onwards shifted the production of coca paste from Peru and Bolivia to Columbia and led to a huge boom in the demand for Columbian coca leaf. This has led to more self-employment and work for teenage boys in rural areas, but not to widespread economic spill-over effects, and the financial opportunities that coca provides has fuelled violence and civilian conflict especially outside the major cities (Angrist and Kugler, 2005). Greenland is a socialist economy which benefits from a large annual grant from Denmark to ensure a similar GDP per capita to the Danish one. It seems to have suffered from an appreciated real exchange rate as well as rent seeking from an unusually comprehensive system of state firms and price regulations (Paldam, 1997).

Others discuss more positive experiences of resource rich economies. Forty percent of Botswana's GDP stems from diamonds, but Botswana has managed to beat the resource curse. It has the second highest public expenditure on education as a fraction of GNP, enjoys the world's highest growth rate

since 1965 and its GDP per capita is at least ten times that of Nigeria (Sarraf and Jiwanji, 2001; Challender et. al., 2003). The Botswana experience is especially noteworthy, since it started its post-colonial experience with minimal investment and substantial inequality. Of 65 resource rich countries only four managed to achieve long-term investment exceeding 25 percent of GDP and an average GDP growth exceeding 4 per cent, namely Botswana, Indonesia, Malaysia and Thailand (Gylfason, 2001). These three resource rich Asian countries have managed to do this by economic diversification and industrialisation. Still, they fared less well than their neighbours Hong Kong, Singapore and South Korea with little raw material wealth.

Norway has shown a remarkable growth performance of manufacturing and the rest of the economy compared with its neighbours despite a phenomenal growth in oil exports since 1971 (Anderssen, 1993; Larsen, 2004). Indeed, Norway is the world's third largest exporter after Saudi-Arabia and Russia. Noteworthy is that Norway is one of the least corrupt countries in the world. Iceland enjoys large revenues from fisheries. In contrast to other industrial countries, non-resource exports of Norway and Iceland have grown less rapidly than GDP during the last forty years. However, neither country suffers much from corruption or rent seeking, because of their well developed institutions, far sighted management and market friendly policies.

The United Arab Emirates account for close to 10 and about 4 percent of the world's crude oil and natural gas reserves, but has turned its resource curse into a blessing (Fasano, 2002). Its government debt is very small, inflation is low and hydrocarbon wealth has been used to modernise infrastructure, create jobs and establish a generous welfare system. Major strides in life expectancy and literacy have been made through universal and free access to education and health care. In anticipation of the depletion of its natural reserves, oil-rich Abu Dhabi has emphasised petrochemical and fertilisers, Dubai has diversified into light manufacturing, telecommunications, finance and tourism, and the other emirates have focused at small-scale manufacturing, agriculture, quarrying, cement and shipping services.

Many Latin American countries have abandoned misguided state policies, encouraged foreign investment in mining and increased the security of mining investment. Since the 1990's Latin America appears to be the fastest growing mining region, well ahead of Australia, Canada, Africa and the US in terms of spending on exploitation. Chile has recently achieved remarkable annual growth rates of 8.5 percent while the mining industry accounted for almost half of total exports. Peru ranks second in the world in the production of silver and tin, fourth in zinc and lead and eighth in gold and its mineral sectors enjoy prospects for further growth. Another leader in this region is Brazil. Argentina seems to be moving ahead as well.

The positive experiences of the US with its mineral abundance from the mid-nineteenth to the mid-twentieth century explain much of the later economic growth (Habbakuk, 1962; David and Wright, 1997). It was a choice driven by collective learning and leading education in mining engineering and metallurgy, increasing returns and an accommodating legal environment where the US government claimed no ultimate title to the nation's minerals (Wright and Czelusta, 2002, 2004). The lesson is that one has to learn to make the most of one's resources. The US was the world's leading mineral economy in the very period that the country became the world leader in manufacturing. Linkages and complementarities to the resource sectors were vital to the American economic success. Coal and iron ore deposits spurred industrial development of Germany and the UK as well during the late nineteenth century. More recently, transport costs have fallen enormously. South Korea and Japan have taken advantage of this and have become important steel producers despite relying on the import of iron ore. Still, history shows that good experience of resource rich economies are not always replicated. In the seventeenth century resource poor Netherlands outpaced Spain, even though the latter obtained lots of gold and silver from its colonies in the New World. More recently, resource poor Switzerland has an excellent economic performance compared with resource rich Russia. In sum, the effects of natural resources on the economy vary from country to country and across different episodes in history.

### *2.2. Cross-country empirical evidence*

It is important to have systematic cross-country evidence on whether a national resource curse exists or not. Figure 1 (see Annex) gives a first glance at the data and indeed suggests that there is a negative link between growth performance and the share of natural resources in merchandise exports. The pioneering study on the empirical cross-country evidence shows that resource rich countries grow on average about one percentage point less during 1970-89 (Sachs and Warner, 1995). The revised cross-country regressions explaining the average growth in real GDP per capita during 1970-1990 are reported in the first column of results of Table 1. There is evidence of conditional convergence, since countries with a low (logarithm of the) level of initial real GDP per active member of the population catch up and grow relatively fast. Countries that invest a lot (with a high log of ratio of real public and private gross domestic investment to real GDP averaged over the period 1970-89), grow faster. Countries with a large number of years in which their economy is rated as open and whose citizens accept the rule of law more easily (on a scale from 1 to 6), grow faster. Interestingly, even once account is taken of these traditional factors influencing growth, there is a strong negative effect of resource abundance (as measured by the share of exports of primary products in GNP in 1970) on the rate of economic growth. This is what has become known as the natural resource curse. In this pioneering cross-country evidence there is no role for quality of institutions or bureaucratic quality in explaining the natural resource curse. The second regression reported in Table 1 uses a dataset with more countries, a longer data period and an index of institutional quality (on a scale from 0 to 1). Using the starting year 1965 rather than 1970, this regression confirms that resource rich economies experience slower growth and that institutional quality is not significant at the 5 percent level.

**Table 1: Effects of resource abundance and institutional quality on economic growth**

| Annual growth in real GDP per capita | Sachs and Warner (1997a) | Based on data in Sachs and Warner (1997b) | Mehlum, Moene and Torvik (2005a) |
|---|---|---|---|
| Initial income | -1.76 (8.56) | -1.28 (6.65) | -1.26 (6.70) |
| Openness | 1.33 (3.35) | 1.45 (3.36) | 1.66 (3.87) |
| Resource abundance | -10.57 (7.01) | -6.69 (5.43) | -14.34 (4.21) |
| Rule of law | 0.36 (3.54) | - | - |
| Institutional quality | - | 0.6 (0.64) | -1.3 (1.13) |
| Investments | 1.02 (3.45) | 0.15 (6.73) | 0.16 (7.15) |
| Interaction term | - | - | 15.40 (2.40) |
| Number of countries | 71 | 87 | 87 |
| Adjusted $R^2$ | 0.72 | 0.69 | 0.71 |

However, subsequent work demonstrates that the adverse effect of resource abundance on economic growth is particularly strong in economies with weak institutions (Mehlum, Moene and Torvik, 2005ab). The third regression reported in Table 1 indicates that for countries with a high enough index of institutional quality (i.e., greater that 14.34/15.4=0.93) the natural resource curse does not apply. This holds only for 15 out of the 87 countries (among which the US, Canada, Norway, the Netherlands, New Zealand and Australia) in the sample. In fact, there are five countries that belong both to the top eight according to natural resource wealth and to the top 15 according to per capita income. Resource rich countries with bad institutions typically are poor and remain poor. Related cross-country evidence also strongly suggests that natural resources—oil and minerals in particular – exert a negative and nonlinear impact on growth via their deleterious impact on institutional quality[1] rather than through a worsening of competitiveness of the non-resource export sectors (Sala-i-Martin

1 This variable is instrumented by mortality rates of colonial settlers (cf., Acemoglu et. al., 2001) and the fraction of the population speaking English and European languages (cf., Hall and Jones, 1999).

and Subramanian, 2003). The adverse effect of resource abundance on institutional quality on economic growth is particularly strong for easily appropriable 'point-source' natural resources with concentrated production and revenues and thus massive rents, i.e., oil and minerals rather than agriculture which is more diffused throughout the economy (Auty, 1997; Woolcock et. al., 2001; Isham et. al., 2003; Murshed, 2004; Mavrotas, et. al., 2006). Bad institutions have an adverse effect on economic growth. They are, typically, more powerful explanations of growth performance than measures of geography and trade or economic policies (e.g., North, 1990; Hall and Jones, 1999; Acemoglu, et. al., 2001, 2003; Rodrik et. al., 2004; Easterly and Levine, 2002), but not everybody agrees fully (Glaeser, et. al., 2004). Still, the key point is that resource abundance makes countries with bad institutions even more vulnerable.

The adverse effects of resource abundance on economic growth survive even after allowing for geographical factors such as kilometres to closest airport, percentage land in tropics or incidence of malaria (Sachs and Warner, 2001). One study suggests that natural resources can positively and permanently boost the level of income and welfare by having a large level of human capital, and that this can offset the direct negative effect of natural resource on the growth rate (Bravo-Ortega and De Gregorio, 2005). This may explain why say Norway has fared better than most resource-abundant Latin-American countries. It is thus important to assess whether a low growth rate with a high level of income per capita is a normal state of affairs or induced by a natural resource curse.

There is a host of further cross-country econometric evidence on the natural resource curse (e.g., Leite and Weidmann, 1999; Gylfason, et. al., 1999; Busby et. al., 2002). An influential study states that natural resources are one of the ten most robust variables in explaining growth (Sala-i-Martin, 1997). Cross-country regressions also suggest that resource wealth may stimulate corruption among bureaucrats and politicians (Ades and Di Tella, 1999).

Natural resource abundance may indirectly harm the economy through other variables that lower growth. There are at least four potential channels of transmission (e.g., Gylfason, 2001, 2004; Papyrakis and Gerlagh, 2004):

1) Partial correlations based on cross-country evidence for oil exporters in the Arab world and other countries suggest that natural resource abundance crowds out non-resource exports and foreign direct investment. It is also clear from evidence of a sample of 87 countries that natural resource wealth is associated with less openness to foreign trade and less openness to gross foreign direct investment, which in turn may harm economic growth.

2) Resource abundance elicits corruption and extreme rent seeking through protection, exclusive licenses to exploit and export natural resources by the political elite, the oligarchs and their cronies in order to capture all the wealth as well as the political power. It also crowds out social capital, erodes the legal system and elicits armed conflicts and civil wars (witness Africa's infamous diamond wars). Indeed, in a sample of 55 countries resource abundance is strongly associated with a lower corruption perceptions index (as measured from Transparency International, Berlin) which in turn is associated with lower economic growth (cf., Mauro, 1995). Resource abundance is also correlated with a bigger Gini index of inequality (also see Gylfason and Zoega, 2003)[2] and less political liberties, which in turn are correlated with lower growth as well.

3) Natural resource wealth may lower incentives to accumulate human capital. Although there are exceptions such as Botswana, there is an inverse correlation between resource abundance on the one hand and school enrolment at all levels, expected years of schooling

2 Still, after controlling for income, resource rich countries may have higher and faster growing social indicators than other countries (e.g., Davis, 1995). This deserves further investigation.

and public spending on education on the other hand (also Gylfason, et. al., 1999; Gylfason, 2001). This may matter as there is a positive correlation between education and growth.

4) In a sample of 85 countries the share of natural resource wealth in national capital is negatively correlated with both gross domestic investment as percentage of GDP and the average ratio of broad money (M2) to GDP (a measure of financial development). Natural resource wealth seems to discourage investment and delay the development of financial institutions. This may well hamper growth.

In future research it is crucial to move from cross-country to panel data evidence in order to avoid the problem of omitted variable bias. One panel data study investigating the link between natural resources, institutional development and economic growth in 91 developing countries during 1970-2000 finds that point-source type natural resources (minerals, coffee, cocoa) retard democratic and institutional development, measured by the degree of democracy for each country over time, and this hampers economic growth (Murshed, 2004; Mavrotas, et. al., 2006; also see Collier and Hoeffler, 2005). Institutional quality thus seems the crucial link between resource endowments on the one hand and economic outcomes on the other hand. They also seem the crucial link between social indicators and resource abundance, since cross-country empirical evidence suggests that indicators of human welfare relating to the human development index, availability of water, nourishment of the population and life expectancy are negatively related to resource abundance through the channel of weakening of institutions (Bulte, et. al., 2005).

Another panel data study finds that the impact of resource abundance on the growth rate found in cross-country regressions disappears once one allows for fixed effects in panel data estimation, which suggests that resource abundance captured by primary exports as a fraction of GNP[3] is correlated with unobservable characteristics (Manzano and Rigobon, 2001). During the 1970's when commodity prices were high, resource rich countries used them as collateral for debt but during the 1980's commodity prices fell significantly. The panel data estimation suggests that this has thrown many resource rich countries into debt crises. Indeed, if debt is also an explanatory variable in the panel data estimation, the effect of resource abundance disappears. The empirical results suggest that the effect of resource abundance is mainly driven by boom-bust cycles induced by volatile commodity prices, debt overhang and credit constraints, less by quality of bureaucracy (data from Knack and Keefer, 1995) or degree of financial development.

The above evidence suggest that resource abundance crowds out foreign capital, social capital, human capital, real capital and financial capital, each of which tends to depress growth. Resource rich countries in the developing work should therefore avoid a false sense of security and aim to reduce their dependence on natural resource wealth by diversifying economic activities. At the same time, they should try to improve the quality of their institutions and legal system, publish how much revenues they want and what they are going to do with it, and cherish transparency and accountability (see section 5).

### *2.3. Natural capital and the wealth of nations*

A recent study calculates the various components of national wealth in the year 2000 for nearly 120 countries in the world (World Bank, 2006). Total national wealth is approximated by the present value of the stream of sustainable consumption from the year 2000 to 2025 using a social discount rate of 4 percent. Produced capital is estimated from historical investment data with the perpetual inventory method. Natural capital consists of subsoil assets, timber resources, non-timber forest resources, protected areas, cropland and pastureland. Unfortunately, due to data problems, fisheries, subsoil

3 A fraction of GNP rather than GDP is used, since GDP includes the production in the resource sector which has been declining during the last three decades.

water and diamonds are excluded and the explicit value of ecosystems is not evaluated either. The value of natural capital is estimated from world prices and local costs. Intangible capital reflects the contribution of raw labour, human capital, R&D, social capital and other factors such as the quality of institutions and the rule of law. It is calculated residually as the excess of total national wealth over the sum of produced and natural capital and is well explained by school years per capita, a rule of law index and remittances per capita. For example, an extra year of schooling yields extra intangible capital varying from $840 for low-income to $16,430 for high-income countries.

Tables 2 and 3 give a flavour of the detailed results. Although global wealth per capita is $96.000, this masks huge variety across countries. The share of produced assets in total wealth is more or less the same irrespective of how poor or rich a country is. However, the share of natural capital in total wealth is much higher in poorer countries while the share of intangible capital in total wealth is substantially higher in richer economies. Interestingly, richer countries have a substantially higher value of natural capital per capita despite having lower shares of natural capital in total wealth. The results confirm what we know from the literature on economic growth that intangible capital is the main engine of growth and wealth creator. Richer countries focus relatively more at dynamic sectors such as manufacturing and services, whereas poorer countries specialise in the more static primary sectors. Table 3 indicates that the poorer countries rely relatively heavily on land resources (more than two thirds of natural wealth in low-income countries).

**Table 2: Total wealth, 2000**

| — $ per capita and percentage shares — | | | | | | | |
|---|---|---|---|---|---|---|---|
| Income group | Natural capital | Produced capital | Intangible capital | Total wealth | Natural capital share | Produced capital share | Intangible capital share |
| Low-income countries | 1,925 | 1,174 | 4,434 | 7,532 | 26% | 16% | 59% |
| Middle-income countries | 3,496 | 5,347 | 18,773 | 27,616 | 13% | 19% | 68% |
| High-income OECD countries | 9,531 | 76,193 | 353,339 | 439,063 | 2% | 17% | 80% |
| World | 4,011 | 16,850 | 74,998 | 95,860 | 4% | 18% | 78% |

Source: World Bank (2006, Table 2.1). *Note:* All dollars at nominal exchange rates. Oil states excluded.

**Table 3: Natural capital, 2000**

| — $ per capita — | | | | | | | |
|---|---|---|---|---|---|---|---|
| Income group | Subsoil assets | Timber resources | NTFR | Protected Areas | Cropland | Pastureland | Total natural capital |
| Low-income countries | 325 | 109 | 48 | 111 | 1,143 | 189 | 1,925 |
| Middle-income countries | 1,089 | 169 | 120 | 129 | 1,583 | 407 | 3,496 |
| High-income OECD countries | 3,825 | 747 | 183 | 1,215 | 2,008 | 1,552 | 9,531 |
| World | 1,302 | 252 | 104 | 322 | 1,496 | 536 | 4,011 |

Source: World Bank (2006, Table 1.2). *Note:* NTFR stands for non-timber forest resources. Oil states excluded.

In the top ten of wealthiest countries only Norway has a natural capital share of more than 3 percent (namely 12 percent). On the other hand, the bottom ten countries all have shares of natural

capital in total wealth exceeding 30 percent. In fact, Table 4 shows that highly resource rich economies, such as the oil exporters Nigeria, Venezuela and Algeria, sometimes even have negative shares of intangible capital in total wealth. This indicates that these countries have extremely low levels of GNI as their returns on productive and intangible capital are very low and possibly even negative. Consequently, they have very low total wealth and can sustain only very low levels of consumption per capita. This is another manifestation of the resource curse.

**Table 4: Intangible capital and composition of wealth in highly resource-dependent countries**

| | | Percentage share of total wealth | | |
|---|---|---|---|---|
| Country | Intangible capital per capita ($) | Natural Capital | Produced Capital | Intangible Capital |
| Russian Federation | 6,029 | 44 | 40 | 16 |
| Guyana | 2,176 | 65 | 21 | 14 |
| Moldova | 1,173 | 37 | 49 | 13 |
| Venezuela, R.B. de | 4,360 | 60 | 30 | 10 |
| Gabon | -3,215 | 66 | 41 | -7 |
| Syrian Arab Rep. | -1,598 | 84 | 32 | -15 |
| Algeria | -3,418 | 71 | 47 | -18 |
| Nigeria | -1,959 | 147 | 24 | -71 |
| Congo, Rep. of | -12,158 | 265 | 180 | -346 |

Source: World Bank (2006, page 29).

## 3. Popular explanations of the natural resource curse

### *3.1. De-industrialisation caused by appreciation of the real exchange rate*

Early contributions highlight the process of de-industrialisation caused by the appreciation of the real exchange induced by the increase in oil exports in Britain (Forsyth and Kay, 1980, 1981). Also, the Netherlands has seen a relative decline of Dutch manufacturing as a result of the worsening of competitiveness associated with the export of natural gas found in Slochteren (Ellman, 1981). The idea behind this so-called Dutch Disease is that the extra wealth generated by the sale of natural resources induces an appreciation of the real exchange rate and a corresponding contraction of the traded sector (e.g., Corden and Neary, 1982; Corden, 1984). This may be illustrated with the Salter-Swan model of a dependent economy (see appendix A). Labour is mobile between the traded and non-traded sectors, so must be paid the same in both sectors. An increase in the relative price of non-traded goods pushes up the value of the marginal product of employment in the non-traded sector, so employment in the traded sector must decline in order to push up the marginal product of labour in the traded sector. This is represented by the upward-sloping LM-locus in Figure 2 (see Annex). An increase in the relative price of non-traded goods induces a shift in demand away from non-traded towards traded goods, so workers must shift from the non-traded to the traded sector in order to ensure that supply equals demand. This is represented by the downward-sloping NTGME-locus in Figure 2. An increase in natural resource revenues boosts national income and demand. Hence, the NTGME-locus is shifted upwards and the equilibrium shifts from A to A′. The short-run consequences of an increase in natural resource revenues are thus an appreciation of the real exchange rate (i.e., an increase in the relative price of non-traded goods), a decline of the traded sector and a boost of the non-traded sector. Labour shifts from the exposed to the sheltered sectors. Welfare increases as a result of the natural resource bonanza.

For the longer run effects one must allow both capital and labour to be mobile factors of production in the traded and non-traded sectors and move beyond the specific factors framework. In an open economy Heckscher-Ohlin framework with competitive labour, capital and product markets, no resource use in production and constant returns to scale in the production of traded and non-traded goods, a natural resource discovery induces a rise in the wage-rental ratio if the non-traded sector is

more (less) labour-intensive than the traded sector. In any case, there is a rise in the relative price of non-traded goods (i.e., an appreciation of the real exchange rate) and a contraction of the traded sector and an expansion of the non-traded sector. Labour and capital shift from the traded to the non-traded sectors.

It would be realistic and interesting to investigate the consequences of a resource boom in a dynamic dependent economy with adjustment costs for investment and allow for costly sectoral reallocation of capital between non-traded and traded sectors (e.g., Morshed and Turnovsky, 2004). It is then more costly to transform one form of existing capital into another, since this involves demolition. This way one has factor specificity for each sector in the short run and factor mobility across sectors in the long run. An advantage of this approach is that in the short and medium run the real exchange rate is no longer fully determined by the supply side and does not adjust instantaneously. One could also use a model of endogenous growth in the dependent economy (e.g., Turnovsky, 1996) to explore the implications of a resource boom on economic growth.

The decline in the traded sector is the appropriate market response to an increase in natural resource revenues and in itself does not justify government intervention. The interesting question is why it should be viewed as a problem, since it is optimal for countries to specialise in whatever is their comparative advantage. However, if the traded sector benefits more from learning by doing and other positive externalities than the non-traded sector, exploitation of natural resources may justify government intervention. The concern is that export sectors like manufacturing are hit by the worsening of competitiveness, but unable to recover when natural resources run out. This can be demonstrated in a two-period, two-good Salter-Swan model where learning by doing is captured by future productivity of the traded sector increasing with current production of traded goods (van Wijnbergen, 1984a) or by focusing at trade and dynamic economies of scale where productivity depends on cumulative experience (Krugman, 1987).[4] The appropriate policy response is to have a temporary subsidy or tax relief for the traded manufacturing sector to compensate for the loss in learning by doing. One must, of course, be careful with such a policy recommendation, since business will fiercely resist the dismantling of subsidies when resource revenues dry up.

If manufacturing in contrast to agriculture enjoys learning by doing and the income elasticity of demand for agricultural goods is less than unity, a shift away from manufacturing towards agriculture lowers the rate of endogenous economic growth in an open economy (Matsuyuma, 1992). Similarly, if human capital spill-over effects in production are generated only by employment in the traded sector and induce endogenous growth in both the traded and the non-traded sectors, export of natural resources lowers employment in the traded sector, hampers learning by doing and thus lowers economic growth (e.g., Sachs and Warner, 1995; Gylfason, et. al., 1999). With perfect international capital mobility, the wage, the relative price of non-traded goods and the capital intensities in the traded and non-traded sectors are pinned down by the world interest rate. An increase in natural resource revenues then induces a gradual movement of labour from the traded to the non-traded sector. This reduces learning by doing and thus lowers the rate of labour-augmenting technical progress. As a consequence, the resource boom permanently lowers the rate of economic growth. It is possible to show that non-resource GDP falls on impact after a natural resource discovery if the traded sector is relatively more capital-intensive. It is interesting to consider the more general case where the production of traded goods requires resources as a factor input. In that case, an increase in the world price of resources induces along the factor price frontier a depreciation of the real exchange rate and a fall in the capital intensity in the production of non-traded goods. This accentuates the fall in traded sector employment and thus lowers the rate of learning by doing and the rate of economic growth even further (see Appendix B).

To illustrate how a natural resource boom might affect the *relative* productivity growth of the traded and non-traded sector, the adverse effects of the Dutch disease on economic growth are

4 These explanations of the Dutch disease also explain why giving aid to developing countries may lead to an appreciation of the real exchange rate and a decline of manufacturing (e.g., Adam and Bevan, 1999, 2004; Adam and Connell, 2004).

illustrated within the context of a dynamic dependent economy without capital accumulation, absence of current account dynamics and balanced trade (Torvik, 2001). Both traded and non-traded sectors contribute to learning. A foreign exchange windfall arising from the export of natural resources leads in this context to an appreciation of the real exchange rate in the short run, but a real depreciation in the long run. To illustrate how this works, allow the growth rate in productivity of each sector to increase with the number of people employed in that sector and suppose that these learning by doing effects are more substantial in the traded than in the non-traded sector. Suppose also that the elasticity of substitution between traded and non-traded goods in consumption is less than unity. One can then show that a decline in the relative productivity of the traded sector induces a depreciation of the real exchange rate and a fall in labour use in the non-traded sector (see appendix C). In fact, an increase in natural resource exports leads on impact to real appreciation and expansion of the non-traded sector. Over time the relative productivity of the traded relative to that of the non-traded sector declines gradually. This eventually completely chokes off the initial expansion of the non-traded sector and eliminates the boom of the traded sector through gradual depreciation of the real exchange rate. The new steady-state level of production has also moved in favour of the non-traded sector, not due to reallocation of labour but due to the relative fall in the productivity of the traded sector (see Figure 2).

It is also relevant to consider the effect of the exploitation sector using labour and capital as factor inputs. Apart from the hitherto discussed *spending* effects of a natural resource boom, there are then also *resource movement* effects (Corden and Neary, 1982). De-industrialisation then occurs on account of the usual appreciation of the real exchange rate (the *spending* effect), but also due to the labour drawn out of both the non-traded and traded sectors towards the resource sector (the *resource movement* effect). Looking at the longer run where both factors of production (labour and capital) are mobile between the traded and non-traded sectors and the resource sector only uses labour, it is appropriate to consider a mini-Heckscher-Ohlin economy for the traded and non-traded sectors. The Ryczynski theorem then implies that the movement of labour out of the non-resource towards the resource sectors causes output of the capital-intensive non-resource sector to expand. This may lead to the paradoxical result of pro-industrialisation if capital-intensive manufacturing is the traded sector, but this may be offset by the de-industrialisation effects arising from an appreciation of the real exchange rate.

In the less likely case that the non-traded sector is more capital intensive than the traded sector, the real exchange rate will depreciate if labour is needed to secure the windfall natural resource revenues (Corden and Neary, 1982). The Rybczynski theorem suggests that the non-traded, capital-intensive sector expands and the traded sector contracts. This increase in the relative supply of non-traded goods fuels the depreciation of the real exchange rate. A real exchange depreciation may also result from a boost to natural resource exports if the traded sector is relatively capital intensive and capital is needed for the exploitation of natural resources (Neary and Purvis, 1982). Since less capital is available for the traded non-resource sector, less labour is used and thus more labour is available for the non-traded sector. This may lead to a depreciation of the real exchange rate. This also happens if the income distribution is shifted towards consumers with a lower marginal propensity to consume non-traded goods (Corden, 1984). Hence, there are a variety of reasons why a natural resource boom may be associated with depreciation rather than appreciation of the real exchange rate.

An increase in the world price of natural resources can in the presence of short-run nominal rigidities have significant effects on unemployment and inflation (e.g., Eastwood and Venables, 1982; Buiter and Purvis, 1983; van Wijnbergen, 1984b). Although the direct effect of an oil price increase is an increase in the demand for the domestic manufacturing good, that effect may be swamped by a real appreciation created by the increased demand for the home currency. The result may be a decline in domestic manufacturing output and an increase in unemployment as well as a temporary rise in inflation. The oil price shock has elements of both a demand and supply shock, but an increase in resource reserves is mainly a demand shock. Natural resource discoveries generate permanent income effects well beyond the productive life of the new natural resource reserve. The initial increase in

income above its permanent level leads to a current account surplus, but is reversed when the reserve runs out. The resource discoveries do not necessarily imply a shrinking of manufacturing exports or output and an increase in unemployment.

In more comprehensive numerical simulations of Dutch disease effects in economies with traded and non-traded goods, it is desirable to employ perfect-foresight, intertemporal general equilibrium models. One can then allow for temporary real wage rigidity, short-run capital specificity and long-run capital mobility between sectors, international capital mobility, intermediate inputs, adjustment costs of investment, dynamics of capital accumulation, government debt and current account imbalances, and far-sighted behaviour of firms and households (e.g., Bruno and Sachs, 1982). With overlapping generations or household liquidity constraints, it matters whether the government uses the natural resource revenues to reduce public debt or increase transfers. Oil price shocks then induce real appreciation and transient unemployment. It is worthwhile to investigate further the effects of resource abundance on wage formation in competitive and non-competitive labour markets (cf., Chatterji and Price, 1988; Brunstad and Dyrstad, 1997). Capital market imperfections may also generate adverse growth effects of resource booms. For example, if resource income cannot be invested in international capital markets, resource rich economies may experience slower steady-state growth as people live beyond their means and are overshooting their steady-state levels (Rodriquez and Sachs, 1999).

Resource rich countries with a predatory state, little international trade, few incentives for the development of capital, weak linkages between the natural resource and other sectors of the economy, and lack of economic diversification into competitive manufacturing industries are likely to follow a staple trap path with growing income inequality and slow accumulation of social capital (e.g., Auty, 2001a, 2004). However, historical accounts indicate that resource booms do not always worsen economic performance. If one distinguishes between an industrialised Europe, the 'new economies' (Australia, Canada and the US) and tropical subsistence agricultural economies without manufacturing, a resource boom can indeed lead to growth expansion (Findlay and Lundahl, 1994; Murshed, 2001, 2004). Globalisation has after all raised the demand and price of primary commodities produced both in the tropics and the 'new economies'. This has raised the rental rate on land used in primary goods production, boosted the demand for labour in these regions and shifted factors away from subsistence farming to mining. Manufacturing also expands in Europe and the 'new economies' driven by the fall in the interest rate. The real wage rises also in the tropics (with point-source resources, typically, captured by the landlords), which finances additional land clearance and allows the resource sector to expand. The 'new economies' benefit from the backward and forward linkages to manufacturing, that is from competitive industrialisation. They also enjoy growing per capita incomes. The tropics never industrialise and stagnate into a staple trap, especially in point-source economies. Latin America has many point-source economies while East Asia has more diffuse economies, which may explain why the former have less impressive growth records (Sachs, 1999).

The key point is that the resource curse can be avoided with the right institutions and policies. A big demand push may be needed to generate enough demand complementarities to expand the size of the market and recover the fixed costs of industrialisation, and thus to get developing economies out of low-income traps (cf., Murphy et. al., 1989). In that case, a natural resource boom may be an important catalyst of growth, development and the transition from cottage industry to factory production only if learning by doing and increasing returns to scale are stronger in non-traded than traded sectors (Sachs and Warner, 1999). Unfortunately, in many countries resource booms have done little to set off a dynamic growth process.

### *3.2. Volatility of world resource prices harms exports and output*

The adverse effects of natural resources on the economy may also result from sensitivity to volatility of commodity prices on the world market. Natural resource revenues tend to be very volatile (much more so than GDP), because the supply of natural resources exhibits low price elasticities of supply.

Dutch disease effects may also induce real exchange rate volatility and thus to a fall in investment in physical capital and learning, and further contraction of the traded sector and lower productivity growth (Gylfason, et. al., 1999; Herbertsson, et. al., 2000). Volatile resource revenues are not appreciated by risk-averse households, but it is important to realise that the welfare losses induced by consumption risk are tiny compared with those resulting from imperfect financial markets.

In economies with financial market imperfections where only debt contracts are available and bankruptcy is costly, the economy and the real exchange rate become much more volatile if there is specialisation in traded goods and services and the non-resource traded sector is small (Hausmann and Ribogon, 2002). The reason is that shocks to the demand for non-traded goods and services – associated with shocks to resource income – are not accommodated by movements in the allocation of labour but by expenditure switching. This demands much higher relative price movements. Due to bankruptcy costs, interest rates increase with relative price volatility. This causes the economy to specialise away from non-resource traded goods and services, which is inefficient. The less it produces of these goods and services, the more volatile the economy becomes and the higher the interest rate has to be. This causes the sector to shrink further until it vanishes.

It is well known that volatility is bad for growth, investment, income distribution, poverty and educational attainment (e.g., Ramey and Ramey, 1995; Aizenman and Marion, 1999; Flug et. al., 1999). To get round such resource curses, the government could resort to stabilisation and saving policies and improve the efficiency of financial markets. It also helps to have a fully diversified economy, since then shocks to non-traded demand can be accommodated through changes in the structure of production rather than expenditure switching. This is especially important for inefficiently specialised countries such as Nigeria and Venezuela, but less so for diversified countries like Mexico or Indonesia or naturally specialised countries such as some Gulf states. Unfortunately, many resource rich economies are often specialised in production and thus tend to be more volatile.

### *3.3. Resource wealth leads to unsustainable government policies*

Natural resource wealth may encourage countries to engage in 'excessive' borrowing, which can harm the economy in the short and long run (Mansoorian, 1991). Heavy borrowing on the world market induces a depreciation of the real exchange rate in the long run. In an economy with overlapping generations of households without a bequest motive, the generations alive at the time of the exploitation of the natural resource borrow against all future income from the resource exports. The consequence is that future generations have to bear the burden of servicing the debt. The consequent fall of aggregate demand causes a depreciation of the real exchange rate in the long run. Others have also found that resource rich countries have an incentive to borrow excessively (e.g., Manzano and Rigobon, 2001).

In general, a sudden increase in natural resource wealth may reduce the critical faculties of politicians and induce a false sense of security. This encourages politicians to invest in projects that are not really necessary, keep bad policies in force, and dress up the welfare state in a way which is impossible to finance once the natural resource revenues dry up. Politicians are likely to loose sight of the importance of growth-promoting policies, free trade and 'value for money' management. For example, after the discovery of natural gas in the Netherlands and the global oil price shocks during the seventies and eighties and the consequent sharp rise in unemployment, successive Dutch governments responded in an irresponsible way. They increased public employment, raised the level of unemployment and disability benefits, weakened eligibility conditions for benefits, raised the minimum wage, and implemented protective labour market legislation. Starting from the cabinets headed by Prime Minister Ruud Lubbers in 1989, it will have taken more than twenty years to put the Dutch welfare state on a financially sustainable footing again.

Many developing countries made the mistake of trying in vain to encourage industrialisation through prolonged import substitution using tariffs, import quota and subsidies for manufacturing.

Neo-Marxist policy makers in these countries hijacked the Prebisch hypothesis (i.e., the secular decline of world prices of primary exports) by attempting to avoid resource dependency through state-led industrialisation and import substitution. The resource wealth in many of those countries has prolonged these disastrous policies.

Political scientists have advanced a number of reasons why states have a proclivity to adopt and maintain sub-optimal policies (e.g., Ross, 1999). Cognitive theories blame policy failures on short-sightedness of state actors. They fail to take account of the adverse effects of their actions on the generations that come after the natural resource is exhausted, thus leading to myopic sloth and exuberance. These cognitive theories also stress a get-quick-rich mentality among businessmen and a boom-and-bust psychology among policy makers. Societal theories point the finger at abuse of natural resource wealth by privileged classes, sectors, client networks and interest groups. Statist theories talk of a rentier state and fault a state's institutional weakness to extract and deploy resources, enforce property rights and resist the demands of interest groups and rent seekers. All these theories help to explain why governments of resource rich countries may be tempted to institute and maintain bad policies.

### *3.4. Resource wealth induces corruption, rent seeking and armed conflict*[5]

The political economy of massive natural resource rents combined with badly defined property rights, imperfect markets and poorly functioning legal systems provide ideal opportunities for rent seeking behaviour of producers, thus diverting resources away from more productive economic activities (e.g., Gelb, 1998; Auty, 2001ab, 2004). The economic literature also demonstrates that revenues from natural resources are susceptible to rent seeking and wastage of natural resources. Self-reinforcing effects of rent seeking if rent seekers compete and prey on productive entrepreneurs can explain wide cross-country differences in rent seeking (Murphy et. al., 1993; Acemoglu, 1995). A larger number of rent seekers lower returns to both rent seeking and entrepreneurship with possibly large marginal effects on production. Since more entrepreneurs will switch to rent seeking in times of a natural resource boom, there is a possibility of multiple (good and bad) equilibrium outcomes. More rent seekers induce negative external effects that depress profits for remaining entrepreneurs, which stimulate even more people to shift from productive entrepreneurship to wasteful rent seeking. It is also possible that increased entrepreneurship crowds out rent seeking. In particular, private business can invent and supply new substitutes for restricted imports and thus destroy the rents of quota licenses (Baland and Francois, 2000).

The voracity effect can also cause a drag on economic growth as seen after the oil windfalls in Nigeria, Venezuela and Mexico (Lane and Tornell, 1996; Tornell and Lane, 1999). This effect implies that dysfunctional institutions and poor definition of property rights lead to a classical commons problem whereby there is too much grabbing and rapacious rent seeking of natural resource revenues. It supposes, in contrast, a fixed number of rent seekers. Capital can be allocated either to a formal sector where rents may be appropriated and an informal sector with lower returns and no rent seeking. In a resource boom returns to capital investment in the formal sector rise, so that rent seekers can appropriate proportionately more without destroying the incentive to invest in the formal sector. This is the case if there is the possibility of sectoral reallocation (see Appendix D) or, alternatively, if the elasticity of intertemporal substitution is sufficiently high so that groups do not refrain from excessively increasing appropriation. Rapacious rent seeking in a Markov-perfect equilibrium outcome of a differential game then lowers the amount of capital left for investment in the formal sector and reduces growth prospects. In effect, the increased profitability of investment is more than

5 Rent seeking may also be relevant in developing countries that receive foreign aid (Svensson, 2000). In fact, aid can remove the pressure to reform, induce recipients to overstretch themselves, cause a Samaritan's dilemma with the donor expected to bail out bad policies, siphons skilled workers away from government and thus weakens institutions, and spark conflict over aid rents (Brautigam and Knack, 2004; Harford and Klein, 2005).

undermined by each group of rent seekers grabbing a greater share of national wealth by demanding more transfers. As the number of rent seeking groups in society increases, the voracity effect becomes smaller.

Increased corruption also hampers economic growth (Mauro, 1995; Bardhan, 1997; Leite and Weidmann, 1999). Mineral wealth may prevent the redistribution of political power towards the middle classes and thus prevent the adoption of growth-promoting policies (Bourguinon and Verdier, 2000). The main thrust of these explanations is that natural resource wealth has an adverse effect on institutions, since rentier effects allow governments to pacify dissent, avoid accountability and resist modernisation (Isham, et. al., 2003). For example, waste, corruption and the granting of import licenses and other privileges to cronies rather than Dutch disease effects operating through the real exchange rate seem to be why oil riches have had such disastrous effects on long-run performance of the Nigerian economy (Sala-i-Martin and Subramanian, 2003). Resource wealth makes it easier for dictators to buy off political challengers as President Mobuto has been able to do in Congo with its wealth on copper, diamonds, zinc, gold, silver and oil (Acemoglu, Robinson and Verdier, 2004). Natural resource riches allow politicians to bribe voters by offering them well paid, but unproductive jobs and inefficient subsidies and tax handouts (Robinson, Torvik, and Verdier, 2005). Those profiting from the natural resource sector may bribe politicians to provide specific semi-public goods at the expense of support to manufacturing, which lowers welfare if manufacturing enjoys returns to scale (Damania and Bulte, 2003). Natural resources also make it attractive for political elites to block technological and institutional improvements if that would weaken their power (Acemoglu and Robinson, 2005).

As already mentioned, a resource bonanza encourages productive entrepreneurs to shift to rent seeking. With an aggregate demand externality (and a constant tax rate and no external trade), this lowers income by more than the extra income from the resource revenues and thus lowers welfare (Torvik, 2002). It helps to make a difference between countries with production friendly institutions and others with rent grabbing friendly institutions (Mehlum, Moene and Torvik, 2005ab). Suppose that there is a fixed supply of people that have the talent to direct their activities at either rent seeking or productive entrepreneurship. Rent seeking and productive activities are thus competing activities. If there are more productive entrepreneurs, demand in the economy and profits of each entrepreneur increase. This supposes demand complementarities in production (cf., Murphy, et. al., 1989). In contrast, if more of the talented people are rent seekers (political insiders, bureaucrats, oligarchs, war lords, etc.), the gain per rent seeker declines. One can then distinguish two outcomes following a natural resource bonanza. If institutions are strong and encourage productive entrepreneurship, profits of entrepreneurs increase. This means that in equilibrium less people engage in rent seeking and more in productive activities (see outcome A″ in Figure 3 (Annex)). The rent of the resource bonanza is more than dissipated. Examples of resource rich countries with strong institutions are Australia, Canada, the US, New Zealand, Iceland and Norway. This is also true for Botswana (Acemoglu, Johnson and Robinson, 2002).

However, if institutions are weak, the legal system dysfunctions and transparency is low, rent seeking has a higher return and unfair take-overs, shady dealings, corruption, crime, etc. pay off. A resource bonanza thus elicits more rent seekers and reduces the number of productive entrepreneurs. In equilibrium profits fall and as a result the economy is worse off (see outcome A′ in Figure 3). Weak institutions may explain the poor performance of oil rich countries such as Angola, Nigeria, Sudan and Venezuela, diamond rich Sierra Leone, Liberia and Congo, and drug states Columbia and Afghanistan. In those countries institutions are often destroyed by civil wars over the control of natural resources. Dependency on oil and other natural resources hinders democracy and the quality of governance (e.g., Ross, 1999). Also, timber booms have elicited political elites to dissolve forestry management in South-East Asia (Ross, 2001).

We conclude that among the group of resource rich economies there are countries with strong institutions that enjoy higher growth and others with weak institutions that suffer from low growth resulting from a resource bonanza.

The very presence of (especially point-based) natural resource rents may undermine the quality of institutions itself and induce conflict. Under democracy politicians are less able to appropriate resource rents for their own ends, but violent competition with other political fractions is costly as armies need to be paid and property may be destroyed. Theory then suggests that higher natural resource rents biases the political choice away from democracy towards violent conflict especially if politicians are short-sighted while higher income due to higher productivity makes democracy more likely (e.g., Aslaksen and Torvik, 2005). A boost to natural resource rents thus puts democratic institutions to a survival test.

There is a growing amount of evidence that rents from natural resources and primary commodities, especially oil and other point-source natural resources, increase chances of civil conflicts and wars especially in Sub-Saharan Africa through weakening of the state or financing of rebels, sometimes by corporations. It helps to investigate whether civil strife and wars are the result of *grievance*, a sense of injustice about how a social group is treated (e.g., systematic economic discrimination), or *greed* possibly induced by massive rents of point-source resources as in Angola, Congo and Sierra Leone (Murshed, 2002; Olsson and Fors, 2004). The extent of primary commodity exports is the largest single influence on the risk of conflict and the effect is nonlinear (Collier and Hoeffler, 2004).[6] For instance, a country with no natural resources has a probability of civil conflict of merely 0.5 percent, but a country with a share of natural resources in GDP of a quarter has a probability of 23 percent. In many resource rich countries the government seems unable to provide basic security to its citizens, since the wealth of resources elicits violence, theft and looting often financed by rebels and competing war lords (e.g., Skaperdas, 2002; Mehlum et. al., 2002). The effect of natural resources on the incidence and duration of civil wars features strongly in the political science literature (e.g., Ross, 2004; Fearon and Laitin, 2004; Collier, Hoeffler and Sodbom, 2004). In fractionalised countries with many rivalling groups the destruction of output can outweigh the increase in output due to the resource boom, but not in homogenous countries (Hodler, 2004). Oil increases the likelihood of conflict, especially separatist conflict. Lootable resources such as gemstones and drug tend to prolong conflict, but do not make conflict more likely to begin. There is no significant link between (legal) agricultural production and conflict.

## 4. Sustainable management of exhaustible natural resources

An important issue is how to manage exhaustible natural resources and especially how to convert these resources into other durable, non-exhaustible assets. For that purpose, we first discuss the Hotelling rule for the optimal depletion of natural resources and then examine the Hartwick rule for converting resource rents into saving of other assets.

### *4.1. The Hotelling rule and optimal depletion of natural resources*

Most of the literature on the natural resource curse takes the windfall gain from the export of natural resources as manna from heaven. There is an earlier extensive literature, however, on the optimal depletion of exhaustible resources (e.g., Dasgupta and Heal, 1979). The main insight is the so-called Hotelling rule, which says that the annual rate of increase in the price of natural resources on the world market must equal the world interest rate (possibly with some risk premium added to it). The rationale behind this rule is arbitrage. The country should be indifferent between keeping the natural resource under the ground in which case the return is the capital gain on the reserves and selling it and getting a market rate of return on it. It is possible to incorporate such insights to derive the optimal depletion of

6 Wick and Bulte (2005) show analytically the possibility of a non-monotonous relationship between resources and conflict intensity. In fact, point-based resources can trigger intense contests but can also facilitate the coordination on peaceful outcomes. They also demonstrate that contesting resources through violent conflict may yield superior outcomes than contests through rent seeking.

exhaustible resources for a small open economy which uses capital and resources in production, obtains an exogenous return on its investment abroad and faces an elastic demand for its resources on the global market (Dasgupta, Eastwood and Heal, 1978). The accumulation of national assets equals the excess of proceeds from investment abroad, exports of natural resources and income from production over consumption. Maximising utility of households then gives rise to the Hotelling rule in addition to the efficiency conditions that the marginal product of capital should equal the world interest rate and that of resources should equal the marginal revenue of resources (see appendix E). The optimal rate of depletion of natural resources thus equals the elasticity of world demand for its resources times the world interest rate.

These insights on the optimal depletion of natural resources have to my knowledge not been applied in a context where abundant natural resources harm competitiveness, provoke corruption and rent seeking, and ruin economic performance. There are some recent insights within the context of a simple endogenous growth model with learning by doing, finite planning horizons and Dutch disease effects that suggest that after a natural resource discovery, the optimal share of national wealth consumed should be gradually adjusted downwards over time and some Dutch disease effects should be accepted (Matsen and Torvik, 2005). Lower growth in resource rich economies may thus not be a problem, but may be a natural part of an optimal growth path. Obviously, this is an area where there are many possibilities for innovative research.

The Hotelling rule implies that the domestic price of natural resources is set to the corresponding world price. However, in a distorted, non-competitive economy with other taxes and tariffs in place, this is not sound advice. The theory of second best suggests that the government should levy an ad valorum tax on natural resources in line with other ad valorum distortions in the economy (Dixit and Newbery, 1985; Karp and Newbery, 1991).

The literature on the optimal exploitation of oil pays considerable attention to the market structure of oil producing countries. Typically, the monopolist OPEC is considered in conjunction with a competitive fringe of price-following oil-producing countries. The solution proceeds along the lines of the open-loop Nash equilibrium (Newbery, 1981) or better along the lines of the feedback Nash equilibrium (Groot, Withagen and de Zeeuw, 2003). It typically pays for the monopolist to have a period in which prices are set low enough to exhaust the fringe of oil producers and to subsequently enjoy higher monopoly profits.

The problem with non-renewable or exhaustible resources is that they typically lead to steady declines in income per capita. Indeed, if one introduces such a resource into a production function with constant returns to scale, capital and labour run into jointly diminishing returns (Nordhaus, 1992). In the AK model of endogenous growth with environmental resources as factor of production in final output, a positive growth rate of consumption cannot be sustained for ever either (Aghion and Howitt, 1988, Chapter 5). Faster population growth increases the pressure on the finite resource and thus reduces per capita growth. However, many resources such as fisheries, forests and agricultural land are renewable. Still, this raises questions about how a limited renewable resource sector can co-exist with a growing sector in a balanced growth equilibrium. Typically, this requires the rate of technological progress in the use of the resource to be sufficiently faster than in the use of other inputs. If proper account is taken of renewable resources, ongoing growth is feasible (e.g., Bovenberg and Smulders, 1996; Elíasson and Turnovsky, 2004).

### *4.2. The Hartwick rule and genuine saving*

An important issue is whether the exhaustibility of natural resources constrains the growth potential of the economy. One may especially worry about this if natural resources are essential in production. The answer to that question depends crucially on the ease with which reproducible inputs can be substituted for exhaustible natural resources. There is an extensive literature on the normative guide to the optimal depletion of exhaustible resources and intergenerational equity in optimal growth models

(e.g., Dasgupta and Heal, 1979). An important insight is that non-decreasing per capita consumption is infeasible under exponential population growth if resources are essential inputs in production and there is no technical progress (Dasgupta and Heal, 1974; Solow, 1974; Stiglitz, 1974), but feasible with quasi-arithmetic population growth (Mitra, 1983; Asheim et. al., 2005). Another insight that is hotly debated – often within the context of Cobb-Douglas production functions—is the so-called Hartwick rule, which argues that resource rents should be reinvested in reproducible capital. This entails in the absence of population growth a constant savings rate equal to the constant functional share of resource inputs (Hartwick, 1977). Hence, with no population growth and no technical progress, the economy features constant consumption and is thus a maxi-min optimum. If there is positive population growth, a maxi-min optimum requires a constant consumption per head. If consumption per head were rising (falling) over time, social welfare could be increased if earlier (later) generations saved and invested less or consume capital at the expense of later (earlier) generations. In that case, a maxi-min optimum requires that saving and investment in reproducible capital *exceeds* the resource rents (Appendix F).

In the absence of population growth and technical progress, the Hartwick rule results in a maxi-min optimum in economies with many consumption goods, heterogeneous capital goods and endogenous labour supplies provided there is free disposal and stock reversal (Dixit, Hammond and Hoel, 1980). An interesting question for further research is under what conditions a maxi-min optimum implies adherence to the Hartwick rule (e.g., Withagen and Asheim, 1998; Mitra, 2002).

Another challenge for future research is to investigate how theoretical, normative insights such as the Hotelling and the Hartwick rules should be adjusted to be of use in practical policy formulation. Undoubtedly, this requires one to abandon the assumption of competitive markets with perfect information and allow for a variety of economic distortions. In addition, it is crucial to see how such advice survives in a context where politicians seek re-election and try to grab resource rents for themselves and their allies and institutional quality is poor.

Since consuming rents from exhaustible resources is literally consuming capital, the Hartwick rule of investing resource rents in other forms of capital has appeal for those concerned with sustainable development. In order to obtain some feeling for this, it helps to consider genuine saving (Hamilton and Clemens, 1999; Hamilton and Hartwick, 2005). This is the traditional concept of net saving, namely public and private saving minus depreciation of public and private investment, *plus* current spending on education to capture the change in intangible (human) wealth *minus* the value of net depletion of exhaustible natural resources and renewable resources (forests) *minus* damages of stock pollutants (carbon dioxide and particulate matter). Unfortunately, fisheries, diamonds, subsoil water and soil erosion are not dealt with due to data problems. If genuine saving is positive, a nation becomes richer and social welfare increases, and if it is negative, a nation looses wealth and social welfare falls (e.g., Dasgupta and Mäler, 2000). In fact, wealth per capita is the correct measure of social welfare if the population growth rate is constant, per capita consumption is independent of population size and production has constant returns to scale *and* current saving is the present value of future changes in consumption (Dasgupta, 2001).

The genuine saving estimates calculated by the World Bank (2006) along the lines of Atkinson and Hamilton (2003) are presented in Figure 4 (see Annex) and give an alarming picture. Countries with a large percentage of mineral and energy rents of GNI typically have lower genuine saving rates. This means that many resource rich countries become poorer each year despite large natural resources. They effectively squander their natural resources at the expense of future generations without investing in other forms of intangible or productive wealth. An extreme example is Venezuela. Figure 5 (see Annex) suggests that this may explain why Venezuela shows negative economic growth rates while countries such as Botswana, Ghana and China with positive genuine rates enjoy substantial growth rates. Highly resource dependent Nigeria and Angola have genuine saving rates of minus 30 percent and are impoverishing future generations despite having some GDP growth. The oil/gas states of Azerbaijan, Kazahkstan, Uzbekistan, Turkmenistan and the Russian Federation all have negative

genuine saving rates. All these countries seem to be consuming or wasting rather than investing their resource rents.

Figure 6 (see Annex) performs the counter-factual experiment of calculating by how much productive capital would increase by 2000 if countries would have invested all their natural resource rents from crude oil, natural gas, coal, bauxite, copper, gold, iron, lead, nickel, phosphate, silver and zinc in productive capital since 1970. Unfortunately, the calculations provide an upper bound as they abstract from marginal extraction costs due to data problems. High resource dependence is defined as at least a 5 percent share of resource rents in GDP. We see that especially the resource rich countries who now have negative genuine saving such Nigeria or Venezuela, would experience substantial increases in productive capital by a factor of five or four if the Hartwick rule was followed. This is also true for oil and gas rich Trinidad and Tobago and copper rich Zambia. All the countries in the top right quadrant (except Trinidad and Tobago) have experienced declines in per capita income from 1970 to 2000. Clearly, if the Hartwick rule would have been followed during the last few decades, these economies would have been much less dependent on oil and other resources.

The Solow-Swan neoclassical model of economic growth predicts that countries with high population growth have lower capital intensities and thus lower income per capita. Similarly, in countries with high population growth rates it is possible that genuine saving is positive while wealth per capita declines (World Bank 2006, Table 5.2). Such countries are effectively on a treadmill and need to create new wealth to maintain existing levels of wealth per capita. They thus need to save more than the resource rents (see Appendix F). Sub-Saharan Africa has high population growth rates and shows substantial saving gaps typically of 10 to 50 percent of GNP. For Congo and Nigeria the saving gaps are as high as 110 percent and 71 percent, respectively.

### *4.3. The Hartwick rule in the global economy*

The Hartwick rule is not optimal in the small open economy (see, for example, Appendix E). The capital and resource intensities are then fixed by the world interest rate and resource price, so that it is optimal to have negative saving and running down of physical capital as well as of natural resources. The Hartwick rule would, of course, require the economy to save its resource rents. To examine whether this behaviour is optimal in the global economy, one needs a multi-country framework. To be specific, consider a world consisting of a block of natural resource (say, oil) exporters and another block of oil importers. With free international trade in oil and goods, perfect capital mobility, zero labour mobility, no technical progress, no population growth and identical technologies for both blocks, the maxi-min egalitarian outcome can be characterised (Asheim, 1986, 1996). Factor intensities are determined by the world interest rate and price of oil. The ratios of output, capital, resource use in the oil-exporting block relative to those in the oil-importing block are then identical and equal to the ratio of the labour force in the oil-importing block relative to that in the oil-exporting block.

On the efficient maxi-min path the oil-importing block consumes the full marginal product of its human capital plus its oil rents, but consumes only a fraction of the marginal product of physical capital and the remainder is used to accumulate national wealth to compensate for the decreasing rate of return on capital. This fraction equals one minus the ratio of the share of resource rents to the share of capital income in value added. The oil-exporting block consumes less, since it has no oil rents. If the oil-importing block owned all physical capital, they would be investing all oil rents in physical capital. The oil-exporting block would then be using all resource rents for consumption and running up a foreign financial debt. Oil has no marginal productivity as a stock, but the oil-exporting block can still consume a fraction of the capital gains. The oil exporters can thus indefinitely sustain a positive level of consumption by consuming a fraction of its Hotelling rents, especially if resource rents are large relative to capital income.

Since the Hotelling rule implies that oil exporters enjoy a growing income from oil revenues over time, they need to save less than the Hartwick rule in order to keep consumption per capita constant.

Conversely, oil importers need to save more to be able to afford the increasing cost of oil imports and to sustain a constant level of consumption per capita. In the world economy resource rich economies thus sustain consumption by consuming rather than investing a fraction of their resource rents. To my knowledge, no empirical tests of this proposition are available.

## 5. What can be done to avoid the natural resource rich curse?[7]

Countries such as Botswana, Norway and Canada indicate that resource rich economies can benefit from their natural resource wealth. For this to occur, one needs to have appropriate policies in place. One of these may be a temporary subsidy or tax relief for the non-resource export sectors that are hurt by a worsening of competitiveness resulting from the natural resource bonanza. This is justified if those sectors are characterised by learning by doing and other spill-over effects (van Wijnbergen, 1984a). The problem with temporary aid to those hurt exposed sectors is that may get addicted to it. If the funds are used to stimulate R&D and education directly, this may be less of an issue.

The staple trap view of resource rich countries suggests two possible roads for successful economic reform (e.g., Auty, 2004). The experience of Indonesia and Mexico suggests that, if oil reserves per capita are low, *rapid* economic reforms are more likely to occur as they resolve political extensions by nurturing wealth creation (cf., Usui, 1997). If natural resource reserves promise to sustain rents for a long period in heavily distorted economies, more *gradual* dual-track economic reforms may prove viable as long as the winners of reform can compensate the losers. This can be achieved by creating a dynamic market sector in early-reform geographic enclaves that offer domestic and foreign investors immediate access to post-reform conditions of infrastructure, institutions and incentives. Rapid expansion of the enclaves absorbs surplus labour from the less dynamic, distorted sectors of the economy, and thus builds a pro-reform political constituency. Such gradual dual-track reform may be relevant for countries like Algeria, Angola, Azerbaijan, Iran, Iraq, Kazakhstan, Nigeria and Saudi Arabia.

Another appropriate response that is often advocated is an appropriate form of stabilisation policy. The idea is to put the export revenues from natural resources into a fund. This way the country can spread the benefits of its natural resource wealth over a long time (not unlike the advice offered by the Hartwick rule). As most natural resources are exhaustible and belong to future as well as present generations, it makes sense to use a fund to ensure that future generations benefit from natural resource wealth as well. Such a fund has the added advantage that it enables the government to smooth out volatility in revenues arising from volatility in commodity prices. Norway, Kuwait and many other countries have such a fund. However, if institutional quality is weak and transparency and accountability are not guaranteed, there is a danger that such a fund will be raided, especially if the fund is large (Davis et. al., 2001). Although a petroleum fund may work in Norway, it is not clear that it would work in resource rich countries with rapacious rent seeking and poor institutions. Perhaps, keeping the oil or gold under the ground may be a safer form of saving than putting it in a fund that is easily raided. This is particularly true for something like the Alaska fund, which only distributes the income from the fund rather than the oil revenues itself.

Norway sets a fine example. It has a Special Petroleum Fund with clearly specified rules and procedures and publicly known stabilisation and savings objectives. The SPF is professionally managed, fully integrated with the budget, and enjoys the highest degree of transparency and accountability. Venezuela also has a stabilisation fund, but its integration with the budget is problematic, its management is weak and the rules of operation have quickly eroded. Although poverty is falling at last under President Hugo Chávez, it falls much less than it should given the country's vast oil bonanza. In contrast to Norway, institutional capacity is weak and the country is not very supportive of the fund. Azerbaijan has an extra-budgetary savings fund, which is professionally

7 For early discussions of possible cures of the Dutch disease and management of mineral wealth, see Enders and Herberg (1983), Neary and van Wijnbergen (1986) and Hannesson (2001).

managed, accountable to the President and already fairly transparent. The transparency of the Kazakhstan's National Fund is diluted by Presidential control and limited professionalism. Nigeria has a heavy dependency on oil with needs of the government exceeding oil revenues, a significant backlog of urgent physical and social infrastructure projects, and a volatile pro-cyclical budget. It is therefore unfortunate that Nigeria faces big challenges, since its institutional capacity is weak and its record on transparency and accountability is poor.

An alternative to a fund is to use the natural resource revenues to reduce government debt or to invest in useful education and infrastructure projects with a return at least equal to the market rate of return. Crucial is not to squander the resource wealth in a short period over time, but to make it last for future generations as well.

It is therefore crucial that public and corporate accountability and transparency of all activities to do with the exploitation of natural resources is of the highest standards (e.g., Challender, 2003; Palley, 2003). The accounts related to the production and exports of oil, gas, diamonds, minerals and other resources should be made available to journalists, financial analysts and most importantly the general public. Resource rich governments should also publish what they borrow, since some are tempted to loot the public purse by saddling future generations with excessive debt using natural resource reserves as collateral. Unfortunately, many countries that are worst affected by the natural resource curse do not publish what they earn from exports and do not publish where the revenues go to. Voluntary compliance is thus likely to fail, but exploitation corporations still have to deal with unrepresentative governments. Corporate ethics and codes of governance in resource rich countries with poor institutions are thus crucial. Exploitation companies should publish their payments to all governments and use their influence individually and industry-wide to support mandatory mechanisms for disclosure. Governments on whose territory exploitation companies are registered should require mandatory reporting of revenues to all governments, encourage corporate social responsibility and punish illegal exploitation of natural resources and collusion in the perpetuation of resource-driven conflict. Mandatory compliance helps willing governments to signal that they are serious about accountability and transparency. It also ensures a level playing field among exploitation corporations and avoids unfair competition from corporations that are not constrained by human right or anti-corruption concerns.

It helps if western banks and international organisations deem odious debt incurred by corrupt governments at the expense of their people illegitimate and make a real effort to recover stolen assets. The World Bank under James Wolfensohn and now under Paul Wolfositz have made fighting the 'cancer of corruption' its top priority even if this means insisting on a free press and perhaps even meddling in politics. For example, debt relief for the Republic of Congo with far from transparent finances of the state oil company was given contingent on a three-year record of anti-corruption efforts.

Civil society including shareholders of exploitation companies should hold governments and exploitation companies accountable for their management of mineral resources. To ensure the trustworthiness of the published accounts, it is desirable to establish a global public information office. Posting all the relevant information with this office could be a condition for aid and finance from international organisations such as UNDP, the World Bank and the IMF. The OECD should move ahead with tightening anti-corruption controls covering corporations supported by official export credit agencies. It is interesting that the chairman of the African Union, the Nigerian President Olusegun Obasanjo, has recently warned that corruption amounts to a quarter of GDP in Africa and that this occurs mainly in the profitable oil, gas and mining sectors. He called the plundering of natural resources unpatriotic, but also attacked western banks for allowing tainted money to be deposited.

The IMF and the World Bank have advocated privatisation of state-owned oil and mining industries and tendering exploitation rights to private companies. The hope is that this will restore efficiency by restoring the profit motive and enhance transparency and accountability. It also fits in with a political agenda of cutting back interference of the state in the economy. Unfortunately, the

evidence on privatisation is rather mixed. Often, the majority of assets end up in the hands of a few privileged companies. In the former Soviet Union this created a new class of very rich oligarchs while the Russian people hardly benefited from the new riches.

Both theory and empirical evidence suggest that natural resource abundance is particularly harmful in countries with bad institutions and poor legal systems. But it is not clear what policy advice this would entail. Sure, it helps to eliminate corrupt politicians and judges, to have well-defined property rights and to have a credible government that does not appropriate the returns from investment, but the crucial question is how to achieve that. China makes clear that despite the absence of formal private property rights, private entrepreneurs have felt secure enough to invest on a large scale, and conversely for Russia. No wonder that China has a buoyant economy and Russia a stagnant one. Signalling that property rights will be respected in practice may be more important than encoding them in law (e.g., Rodrik et. al., 2004). It is not clear how to proceed in a politically feasible manner towards better institutions, since vested interests have squandered natural resource wealth in the past and are likely to fiercely resist institutional reform.

It might help to distribute the revenues from natural resources automatically and instantaneously directly to the citizens of the country (e.g., Sala-i-Martin and Subramanian, 2003). The right of each citizen to an equal share of natural resource revenues could even be inscribed in the constitution to establish the legal default of full direct distribution of resource revenues to the people. One could argue that the resource dividend should only be handed out to adults in order to avoid unintended increases in fertility or that it should only be given to women as the main drivers of economic development. Given that citizenship or residence will be an eligibility criterion for receiving the resource dividend, there is a clear danger of leakage and fraud. The administrative costs should, however, be manageable. The government can afterwards tax their citizens to fund investment projects, reduce government debt, and/or transfer revenues to a fund. The revenues can also be used for micro-finance and housing guarantees or tied to social targets such as the Millennium Development Goals. The great advantage of this is that the burden of proof is with the government, which has to explain why it wants to spend money and get public support for its plans before it can tax its citizens. Citizens may not use their share of natural resource revenues wisely either, but less resources will be wasted on corruption and rent seeking. The reason is that it is much more difficult to mismanage the resources that come from taxes than those that fall from heaven like manna. One can distinguish between an *endowment* effect, which argues that people put more pressure on the government to abide by the principles of good governance as they feel the cost of waste and corruption as an out-of-pocket cost, and an *information* effect stressing that people get better informed about the magnitude of the resource rents and on how these are spent (Sandbu, 2004). Of course, a key issue is again how to implement such a natural resource dividend to the people in practice and overcome opposition from vested interests. Clearly, it makes sense to establish these dividends at key constitutional moments.

From a public finance point of view the government has to deal with revenue collection, revenue management and revenue disbursement (e.g., McPherson, 2004; Humphreys, 2004). Efficient revenue collection requires adequate incentives, appropriate levels of government take, early and stable revenues, cost containment and administrative simplicity. The natural resource revenues can be collected through royalties, profit taxes or other tax packages, production sharing or equity participation by the state, bonuses, cost recovery provisions, and/or auctioning of concessions. This requires a clear separation of roles and responsibilities with adequate staffing, skills and resources. The legal status of state-owned companies requires special attention. Unfortunately, this is not the case for many countries suffering from a resource curse. Transparent tax collection should be accountable and transparent, so corporate audits, value for money audits, tax audits and national exploitation company audits are essential. Corporate social responsibility of the natural resource exploitation companies need to be stimulated. The government should publicly state its objectives with respect to revenue management from zero to peak production (stabilisation, risk sharing, savings in a fund, etc.),

which instruments it is going to use (unified budgetary and asset management, special resource revenue funds, hedging, fiscal rules, etc.), and how it will disburse revenues.

The government also must explain how it is going to cope with increases in the world price of natural resources, avoid boom-bust cycles, manage the exchange rate, and coordinate the natural resource revenues with foreign-aid inflows. In particular, resource rich countries must aim to make their financial markets more efficient and attempt to diversify their economy in order to be less vulnerable to the adverse effects of real exchange rate volatility. Governments of resource rich countries are typically very dependent on this source of revenues and have to cope with serially correlated resource price shocks. They would benefit from loans, futures contracts, options, insurance and other financial instruments in order to hedge risks and have optimal risk sharing (e.g., Kletzer, Newbery and Wright, 1992). Commitment and sovereign default risk are important factors to take account of. Finally, the government must ascertain the estimated impact of natural resource revenues on different sectors of the economy and investigate whether there is a case for intervention in non-resource sectors to restore competitiveness and promote employment and growth.

Resource rich countries should not spend their windfall profits and aim to maintain their revenues from income taxes in line with growth in national income, even though taxes may be difficult to collect, unpopular and distortionary. Slashing regular tax revenues tends to weaken the linkages between the government and its people. The natural resource revenues can be handed out to the people, put into a fund or directed at targeted public expenditures such as education and R&D.

In resource countries that are ruined by armed conflict an effort should be made to get exploitation companies involved at the peace negotiations table. These companies have an interest to avoid conflict and may help to secure re-employment of ex-combatants. To avoid the political risk that a successful mining tender captures the state, it may help to make contracts conditional upon criteria for regime recognition.

## 6. Concluding remarks

The political economy of resource rich countries has been surveyed. The empirical evidence suggests that countries with a large share of primary exports in GNP have bad growth records and high inequality, especially if the quality of institutions and the rule of law are bad. Of course, it also clear that natural resource abundance may undermined the quality of institutions. The economic argument that a resource bonanza induces appreciation of the real exchange rate and a decline of non-resource export sectors may have some relevance. It is not clear that this warrants government intervention. However, if learning by doing and increasing returns to scale occurs mainly in the traded, non-resource sectors, there may be a case for a temporary subsidy to these sectors. Resource rich countries are also vulnerable to the well-known volatility of commodity prices. More important, a resource boom reinforces rent grabbing, especially if institutions are bad, and keeps in place bad policies (debt overhang, building a too generous welfare state, etc.). There is also evidence that countries with an abundance of point-source natural resources are prone to civil conflict and war. Optimal natural resource management may make use of the Hotelling rule and the Hartwick rule, especially if they are extended to allow for Dutch disease caused by learning by doing in the traded sectors and for corruption and rent seeking. The idea is that countries should invest their natural resource rents into reproducible assets such as physical and human capital. However, a recent World Bank study suggests that resource rich economies squander their natural resource wealth and typically have negative genuine saving rates. Still, countries such as Botswana, Canada, Australia and Norway suggest it is possible to escape the resource curse. Practical suggestions for a better management of natural resources are needed. The best would be to improve the quality of institutions and the legal system and to insist on accountability and transparency of resource revenues, but vested interests will probably oppose that. It may also help to put natural resource revenues in a fund to ensure that the interest of future generations is safeguarded, but in countries with poor institutions such a fund will probably be raided. An interesting alternative is to change the constitution in order to guarantee that the resource

revenues are handed to the public. The government has to subsequently tax its citizens to finance its spending programmes. The advantage is that the burden of proof for spending resource revenues is with the government.

The analysis of resource-rich countries draws on the disciplines macroeconomics, public finance, public policy, international economics, resource economics, economic history and applied econometrics. It also benefits from collaboration with political scientists and historians. The problems that arise are of immense interest to the policy making community. The wide diversity in experiences of countries with large natural resources means that a comparative analysis and an exchange of experiences of managing resource rich economies could be very fruitful, and that real progress can be made in advancing the plight of poor countries with an abundance of natural resources. The discovery of natural resources has too often been associated with devastating political conflicts and disastrous economic performance. The challenge is to manage resource revenues in a way that promotes sustainable economic growth, alleviates poverty and avoid conflict. This challenge is particularly difficult in the resource rich economies of Africa with high population growth rates and poor institutions.

## Appendix A: Worsening of competitiveness of non-resource traded sectors

The easiest way to make the point is in a dependent economy without capital accumulation or international investment. Export of resources thus equals net imports of traded goods, that is $H_TQE=C_T-H_TF(L_T)$ where $Q$ denotes the world price of natural resources, $E$ the volume of exports of natural resources, $C_T$ consumption of traded goods, $L_T$ employment in the traded sector, $H_T$ productivity in the traded and natural resource sectors and $H_TF(L_T)$ output of the traded sector. Non-traded goods market equilibrium requires $C_N=H_NG(L_N)$, where $C_N$ denotes consumption of non-traded goods, $L_N$ employment in the non-traded sector, $H_N$ productivity in the non-traded sector and $H_NG(L_N)$ output of the non-traded sector. With an exogenous supply of labour of one unit, labour market equilibrium requires $L_T+L_N=1$. Households maximise utility $U(C_N,C_T)$ subject to the budget constraint $PC_N+C_T=Y$, where $P$ is the relative price of non-traded goods in terms of traded goods and national income is defined as $Y\equiv PH_NG(L_N)+H_TF(L_T)+H_TQE$. Optimality requires that $U_N/U_T=P$. With CES utility, we have $C_N=Y/(1+P^{\varepsilon-1})P$ where $\varepsilon$ indicates the elasticity of substitution between traded and non-traded goods. The NTGME-locus in Figure 2 is thus described by $P^{\varepsilon}=H[F((1-L_N))+QE]/G(L_N)$ where $H\equiv H_T/H_N$ is the productivity of the traded and resource sectors relative to that of the non-traded sector. The NTGME-locus slopes downward and shifts out if the world resource price or the export of resources increases. Labour mobility between the traded and non-traded sectors requires that labour is paid the same in each sector, so that the value of the marginal product of labour is equalised. This yields the LM-curve $PG'(L_N)=HF'(1-L_N)$, which slopes upward as $F''<0$ and $G''<0$. Higher natural resource exports $QE$ boosts $P$ and thus induces a more than proportionate increase in national income ($dY=H_Td(QE)+C_NdP>H_Td(QE)$). The shift of labour from the traded to the non-traded sector boosts both consumption and output of non-traded goods. Consumption of traded goods rises due to the extra resource revenues and despite the contraction in the production of traded goods.

## Appendix B: Endogenous growth and the Dutch disease

We extend Sachs and Warner (1995) to allow for natural resource use in production of traded goods, $R_T$. The traded and non-traded sectors have the same labour-augmenting productivity growth, fully determined by the share of employment in the traded sector $L_T$. The production functions of the two sectors in extensive and intensive form are thus given by:

$$X_T = F(L_T H, K_T, R_T) \text{ and } X_N = G(L_N H, K_N) \text{ with } H_t=(1+\theta L_{Tt-1})H_{t-1}, \theta>0 \text{ or}$$
$$x_T = X_T / L_T H = F(1, k_T, r_T) \equiv f(k_T, r_T) \text{ and } x_N = X_N / L_N H = G(1, k_N) \equiv g(k_N).$$

The zero profit conditions are $1=c_W(W,r,Q)W+c_r(W,r,Q)r+c_Q(W,r,Q)Q$ and $d_W(W,r)W+d_r(W,r)r=P$, where $W$ indicates the wage, r the exogenous world interest rate, and c(.) and d(.) are the unit-cost functions homogenous of degree one associated with the CRTS production functions G(.) and F(.). They give the price of non-traded goods $P$ and the wage $W$ in terms of the world interest rate r and the world resource price $Q$. Capital market equilibrium demands $Pg(k_N)=f(k_T,r_T)=r$ and gives, together with the condition $f_r(k_T,r_T)=Q$, $k_N$, $k_T$ and $r_T$ in terms of r and $P$ (or $Q$). We obtain (suppressing the effect of r) that $r_T=r_T(Q)$, $r_T'<0$ and:

$$W = W(Q), P = P(Q), \; k_N = k_N(Q) \text{ with } P' = d_W W' = -c_Q/c_W \prec 0 \text{ and } k_N' = -g' P_Q / g'' \prec 0.$$

Along the factor price frontier the wage and the price of non-traded goods decrease if the world price of resources increases. The latter induces a decrease in the capital intensity of the non-traded sector. Overlapping households with logarithmic utility and discount factor $1/(1+\rho)<1$ enjoy wage w when young and receive a natural resource dividend per effective worker of e. It follows that aggregate consumption per effective young worker is given by:

$$c_{Nt}=\left(\frac{\mu}{\mathrm{P}(Q_t)}\right)\left(\frac{1+\rho}{2+\rho}\right)\left[W_t+Q_te_t+\left(\frac{(1+\mathrm{r}_{t-1})}{(1+\rho)(1+L_{Tt-1})}\right)\left(W_{t-1}+Q_{t-1}e_{t-1}\right)\right]=(1-L_{Tt})\mathrm{g}(\mathrm{k}_{\mathrm{N}}(Q_t)),$$

where μ indicates the relative utility weight (and budget share) of non-traded consumption. The factor $(1+L_{Nt-1})$ is necessary to convert from old to young workers, the factor $(1-L_{Nt})$ is to convert output per worker to output per young worker in the non-traded sector and the labour market equilibrium condition $L_{Tt}+L_{Nt}=1$ has been used. This condition for non-traded goods market equilibrium can be written as a stable difference equation $L_{Tt}=\Omega(L_{Tt-1},e_t,e_{t-1},Q_t,Q_{t-1})$ with $0<\Omega_1<1$, $\Omega_i<0$, i=2,3,4,5. An increase in the natural resource dividend induces a gradual shift of employment from the non-traded to the traded sector ($L_T$ falls), so there is less learning by doing and the growth rate of the economy is permanently lowered ($(H_t-H_{t-1})/H_{t-1}$ falls). Clearly, in this setup the resource dividend cannot affect relative productivity. If the resource dividend is driven by an increase in the world price of resources, the depreciation of the real exchange rate and the lower capital intensity in production of non-traded goods lead to even bigger falls in traded sector employment, learning by doing and the rate of economic growth. GDP is given by $Qe+WH+\mathrm{r}(K_T+K_N)=QE+(W+\mathrm{r})H[k_N+L_T(k_T-k_N)]$. Hence, GDP grows at the rate $\xi\theta L_T$ where the non-resource share of GDP is ξ. Non-resource GDP falls on impact after a shock in $Qe_1$ if the traded sector is relatively more capital-intensive, that is $\partial\mathrm{GDP}/\partial(Qe_1)=1+(W+\mathrm{r})H_1(\partial L_{T1}/\partial(Qe_1))(k_T-k_N)<1)$ as $\partial L_{T1}/\partial(Qe_1)<0$.

## Appendix C: Learning by doing and the Dutch disease

It is easy to demonstrate within the context the model of Appendix A that an increase $H$ induces an increase in P and, if ε is greater (less) than one, a fall (increase) in $L_N$. Learning by doing in production in each sector is captured by $\mathrm{d}H_T/\mathrm{d}t=\theta_T L_T H_T$ and $\mathrm{d}H_N/\mathrm{d}t=\theta_N L_N H_N$, $\theta_T>\theta_N>0$, so $\mathrm{dH}/\mathrm{dt}=\{\theta_T[1-\mathrm{L_N}(QE,H)]-\theta_N\mathrm{L_N}(QE,H)\}H$. The adjustment towards the steady state $H=\mathrm{H}^*(QE)$ is stable if $\varepsilon<1$, but unstable if $\varepsilon>1$. Also, $\mathrm{H}^{*\prime}>0$ (or $\mathrm{H}^{*\prime}<0$) if $\varepsilon>1$ (or $\varepsilon<1$). The steady state allocation of labour $L_N=\theta_T/(\theta_N+\theta_T)>½$ is independent of $QE$. If $\varepsilon>1$ and the economy starts off with a relatively high productivity in the traded (non-traded) sector, the economy converges to complete specialization in traded (non-traded) goods and grows at the rate $\theta_T$ (zero). In contrast, balanced growth is more interesting and occurs if $\varepsilon<1$. In that case, after an increase in $QE$ the economy gradually converges to the lower steady state value of $H$, so that over time the productivity of the traded sector declines relative to that of the non-traded sector. The steady state growth rate is given by $\theta_N\theta_T/(\theta_N+\theta_T)$ and thus depends only on *direct* learning by doing effects.

## Appendix D: The voracity effect

Natural resources are raided by N groups. If group $i$ grabs $R_i$ from the common stock of exportable natural resources, the value of the common stock evolves according to:

$$\dot{V}=\mathrm{P}^*\mathrm{r}^*V-\sum_{i=1}^{N}R_i$$

where P* is the price of the exportable. The world return on natural resources is r*. If world prices of natural resources follow the Hotelling rule, r* would equal the world interest rate. Each group of rent seekers maximises separable lifetime utility with discount rate ρ and elasticity of intertemporal substitution σ and invests their assets in the domestic (informal) economy where the return r is lower:

$$\dot{A}_i=\mathrm{r}A+R_i-C_i,\ \text{where}\ \ \mathrm{r}<\mathrm{P}^*\mathrm{r}^*$$

where $C_i$ denotes consumption by group i. The informal economy produces the importable good, which is the numeraire. Consider only interior outcomes of a Markov-perfect differential game. If

N<1+(P*r*-r)/z, power is concentrated, capital is continuously transferred to the informal sector and z=r(1-ρ)+ρσ>0 is the constant propensity of each groups to consume out of private and resource wealth (i.e., $C_i$=z($V$+$R_i$)). Consumption then grows at the rate σ(r-ρ). Conversely, if the number of groups is large enough and σ>N/(N-1), capital is continuously transferred to the more efficient resource sector and the propensity to consume is z=P*r*(1-σ)+ρσ. As power concentration diminishes (N increases), the growth rate reduces. The voracity effect implies that in countries with powerful rent seeking groups:

$$\frac{\partial \dot{V}/V}{\partial \text{P*}} = -\frac{\text{r*}}{\text{N-1}} < 0 \text{ if } \text{N}<1+\frac{\text{P*r*-r}}{\text{z}} \text{ and } \frac{\partial \dot{V}/V}{\partial \text{P*}} = -\frac{\text{r*}\sigma}{\text{N-}\sigma\text{(N-1)}} < 0 \text{ otherwise.}$$

An increase in the raw return P* increases the return on investment and thus the growth rate, but surprisingly this effect is more than outweighed by the increase in rent grabbing. The net result is that an increase in P* lowers the rate of growth. In the first-best outcome with no powerful groups, the effect on growth is always positive (r*σ>0).

## Appendix E: Optimal depletion of exhaustible natural resources

Suppose that there is one traded good and that natural resources are sold on the world market according to the iso-elastic demand schedule $E$=E($Q$), where $Q$ is the price of natural resources. The social planner maximises social welfare subject to the differential equations describing depletion of natural resources and the dynamics of the current account:

$$\text{Max} \int_0^\infty \text{U}(C(t))\exp(-\rho\text{t})\text{dt} \text{ s.t. } \dot{S} = -E - R \text{ and } \dot{A} = \text{r}(A-K) + Y + Q\text{E}(Q) - C$$

where $C$, $S$, $R$, $A$, $K$, $Y$, r and ρ denote consumption, stock of natural resources, resource use in production, national assets, capital stock, domestic production, exogenous world interest rate and subjective rate of time preference, respectively, and $Y$=F($K$,$R$)=$K^\alpha R^\beta$ is a Cobb-Douglas production function with decreasing returns to scale to $K$ and $R$ (α+β<1). It follows from the optimality conditions that:

$$\dot{C}/C = \sigma(\text{r}-\rho), F_K = \text{r}, F_R = Q(1\text{-}1/\eta), \dot{Q}/Q = \text{r}, \dot{E}/E = -\eta\text{r} \text{ with } \eta \equiv -Q\text{E}'/E > 0$$

where η denotes the elasticity of world demand for natural resources and σ the elasticity of intertemporal substitution in consumption. Because world demand for resources is iso-elastic, the Hotelling rule holds despite the departure from perfect competition. Capital and resource use decline over time:

$$\dot{Y}/Y = \dot{K}/K = -\left(\frac{\beta}{1\text{-}\alpha\text{-}\beta}\right)\text{r} < 0, \dot{R}/R = -\left(\frac{1\text{-}\alpha}{1\text{-}\alpha\text{-}\beta}\right)\text{r} < 0.$$

Substituting the rates of decline of $E$ and $R$ into the resource depletion equation and using the marginal factor productivity conditions gives two equations relating $E$(0) and $R$(0) to $S$(0):

$$\frac{E(0)}{\eta\text{r}} + \frac{(1\text{-}\alpha\text{-}\beta)R(0)}{(1\text{-}\alpha)\text{r}} = S(0) \text{ and } R(0)^{-(1\text{-}\alpha\text{-}\beta)} = \left(\frac{\text{r}}{\alpha}\right)^\alpha \left[\text{E}^{-1}(E(0))\left(1\text{-}\frac{1}{\eta}\right)\right]^{1\text{-}\alpha}.$$

It follows that a resource bonanza (higher $S$(0)) lifts the declining paths of resource use and resource exports up (higher $R$(0) and $E$(0)), also lifts the declining paths of capital and production, and depresses the price trajectory (higher $Q$(0)). Since the optimum production in this open economy depends only on world prices, the optimal trajectories of $E$, $R$, $K$, and $Y$ are independent of consumer

preferences (σ and ρ). Substituting these trajectories together with the Euler equation for the growth in consumption into the present value national wealth constraint, one can calculate the initial value of consumption:

$$C(0) = \left[(1\text{-}\sigma)\mathrm{r}+\sigma\rho\right]\left( A(0) + \left(\frac{1\text{-}\alpha\text{-}\beta}{1\text{-}\alpha}\right)\left(\frac{Y(0)}{\mathrm{r}} - K(0)\right) + \frac{Q(0)E(0)}{\eta \mathrm{r}}\right),$$

where $Y(0)$, $K(0)$ and $Q(0)$ directly follow from $E(0)$ and $R(0)$. Since $Y(0)$-r$K(0)$ equals $W(0)$+(1-1/η)$Q(0)E(0)$ and the wage $W$ grows at the same rate as output, households consume a constant fraction of the sum of financial, human and natural resource wealth. Clearly, a higher σ or a lower ρ boosts the growth rate of consumption, but lowers $C(0)$. It is easy to extend the results to a return that declines with the level of foreign investment, e.g, $r$=r(A-K), r′<0, or to allow for some uncertain date in the future at which prices fall due to invention of some new technology or source of resources (Dasgupta, Eastwood and Heal, 1978). Future research may consider extending this type of analysis to economies with a non-trade and a traded non-resource sector, learning by doing, aggregate demand externalities, and rent seeking made possible by weak institutions and poor legal systems. One would then obtain positive insights into the resource curse.

## Appendix F: Illustration of the Hartwick rule

Consider a closed economy with resource depletion $\int_0^\infty R(\mathrm{t})\mathrm{dt} = S_0$, zero depreciation, savings rate $s \equiv \dot{K}/Y$, Cobb-Douglas production $Y$=F($K$,$R$)=$K^{\alpha}R^{\beta}L^{1-\alpha-\beta}$, zero depreciation and a population growth rate equal to ν. Firms maximise profits, so that the marginal product of capital and resources equal the rate of interest and the resource price, respectively. Also, the Hotelling rule requires that the capital gains on resources must equal the interest rate and thus $\dot{\mathrm{F}}_R/\mathrm{F}_R = \dot{Y}/Y - \dot{R}/R = \mathrm{F}_K = \alpha Y/K$. We are interested in which saving rate s sustains a stable consumption per capita. We first check which saving rate sustains a stable income per capita:

$$\dot{Y}/Y - \eta = sr - \alpha\eta + \beta(\dot{Y}/Y - \eta - r) = \frac{(s-\beta)r - \alpha\eta}{1-\beta} = 0 \quad \Rightarrow \quad s = \beta + (\alpha/r)\eta \equiv s^*.$$

If there is no population growth ($\eta$=0), to sustain a constant income per capita all resource rents must be invested in capital (i.e., $QR$=$sY$ or $s$=$\beta$). This is exactly what the Hartwick rule requires and corresponds to a maxi-min optimum, since it also sustains constant consumption per capita. In fact, the Hartwick rule holds for general production functions.[8] If there is positive population growth ($\eta$>0), it is necessary to invest *more* than the resource rents in order to sustain a constant income per capita ($s^*$>$\beta$). To sustain constant consumption per capita ($C/L$=(1-$s$)$Y/L$) with positive population growth, one must have:

$$\frac{\dot{Y}}{Y} - \eta = \frac{\dot{s}}{1-s} \quad \Rightarrow \quad \dot{s} = \left(\frac{1-s}{1-\beta}\right)\left[(s-\beta)r - \alpha\eta\right] = \left(\frac{1-s}{1-\beta}\right)r(s-s^*).$$

8 Differentiating the resource equation $\dot{K} = \mathrm{F}(K,R,L) - C = \mathrm{F}_R R.$ and using the Hotelling rule and the Hartwick rule $\dot{K} = \mathrm{F}_R R$ yields $\ddot{K} = \mathrm{F}_K \dot{K} + \mathrm{F}_R \dot{R} - \dot{C} = (\dot{\mathrm{F}}_R/\mathrm{F}_R)\mathrm{F}_R R + \mathrm{F}_R \dot{R} - \dot{C} = \dot{K} - \dot{C}$, so that the Hartwick rule also guarantees constant consumption for general production functions.

In steady state saving must exceed resource rents to sustain constant consumption per capita. The dynamics of the interest rate $r$ (or of the capital output ratio $r/\alpha$) affects the transient behaviour of the saving rate and follow from:

$$\frac{\dot{r}}{r}=\frac{\dot{Y}}{Y}-\frac{\dot{K}}{K}=\frac{(1-\alpha-\beta)(\eta-sr/\alpha)-\beta r}{1-\beta}\Rightarrow -\beta r/\alpha<0 \text{ if } s=s^*=\beta+\alpha\eta/r.$$

The Hartwick rule implies that the interest rate declines and the capital-output ratio increases over time. The saving rate thus rises over time. The depletion rate $\gamma\equiv R/S$ follows from:

$$\frac{\dot{\gamma}}{\gamma}=\gamma+\frac{(1-\alpha-\beta)\eta-(1-s)r}{1-\beta}\Rightarrow \gamma+\eta-r \text{ if } s=s^*.$$

The steady-state depletion rate is $r-\eta$, so that societies with fast growing populations should deplete their natural resources less rapidly. It is interesting to investigate the robustness of the Hartwick rule in case one allows for depreciation, CES production and optimal lifecycle consumption behaviour. Note that the Hartwick rule is not optimal in the small open economy of Appendix E. The capital and resource intensities are then fixed by the world interest rate and resource price, so that there is a situation of negative saving and running down of physical capital as well as resource capital. Effectively, a small open economy consumes part of the capital gains on its natural resources.

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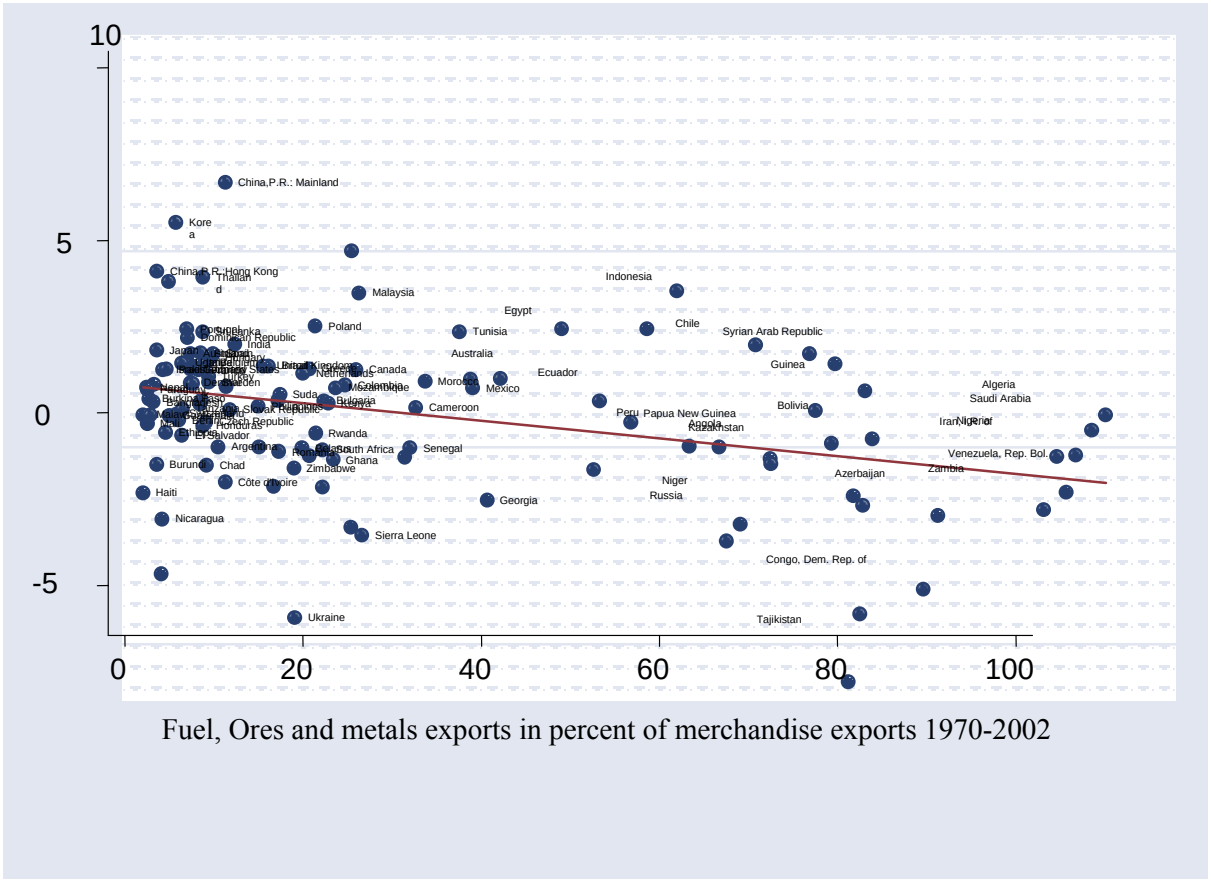
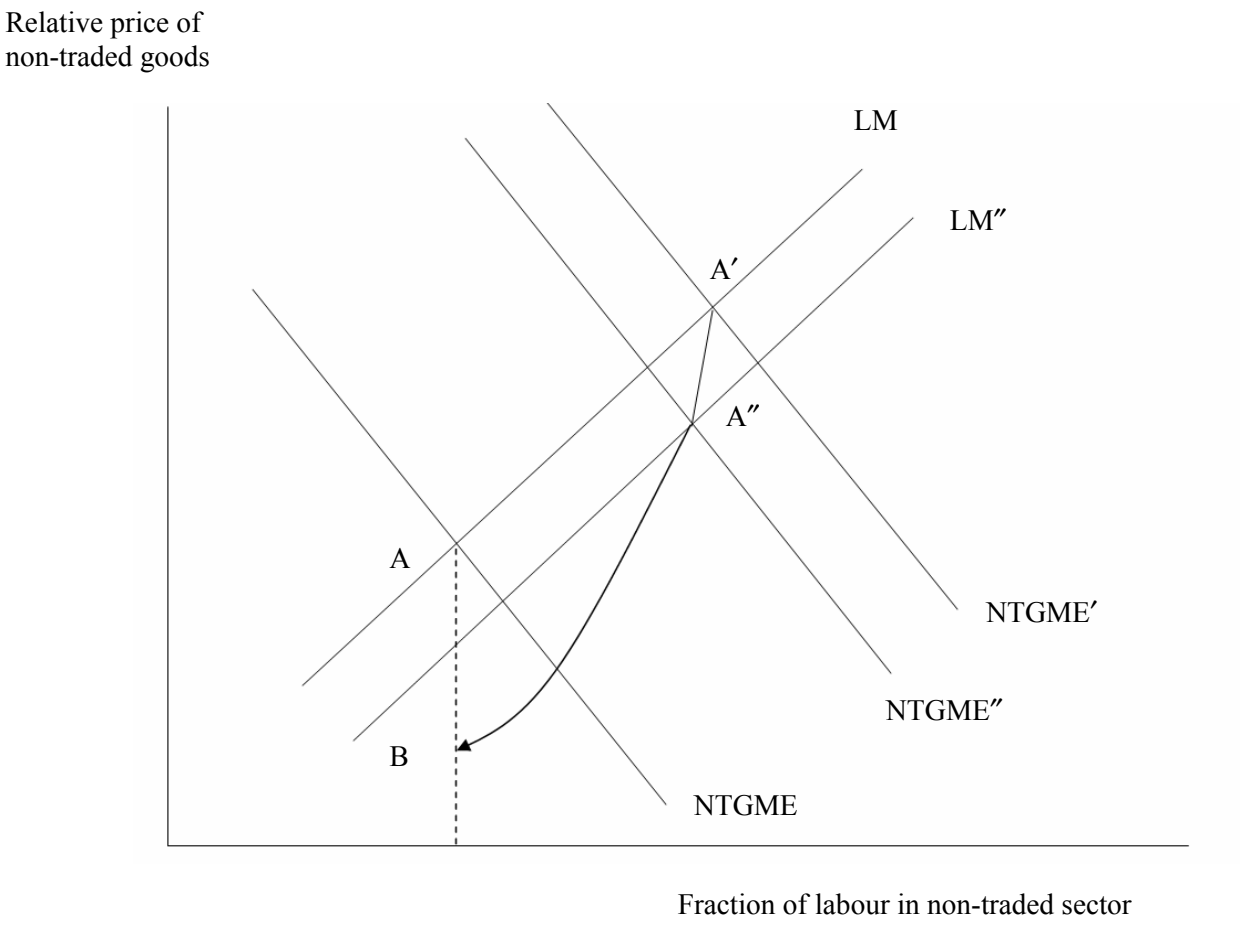
# Annex I: Figures

**Figure 1: Growth and natural resource abundance**




Source: World Development Indicators, 2004, World Bank

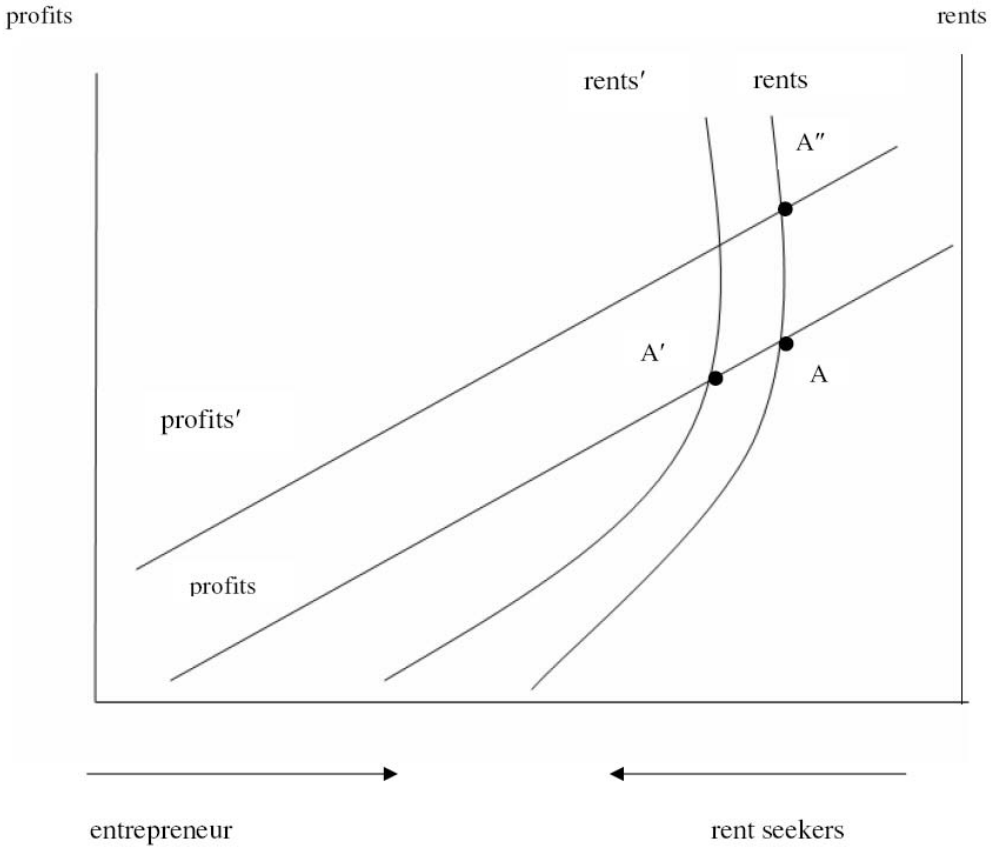
**Figure 2: Natural resource abundance reduces competitiveness**




Key: An increase in natural resource exports shifts A to A′, so induces a shift of production from the traded to the non-traded sector and an appreciation of the real exchange rate.

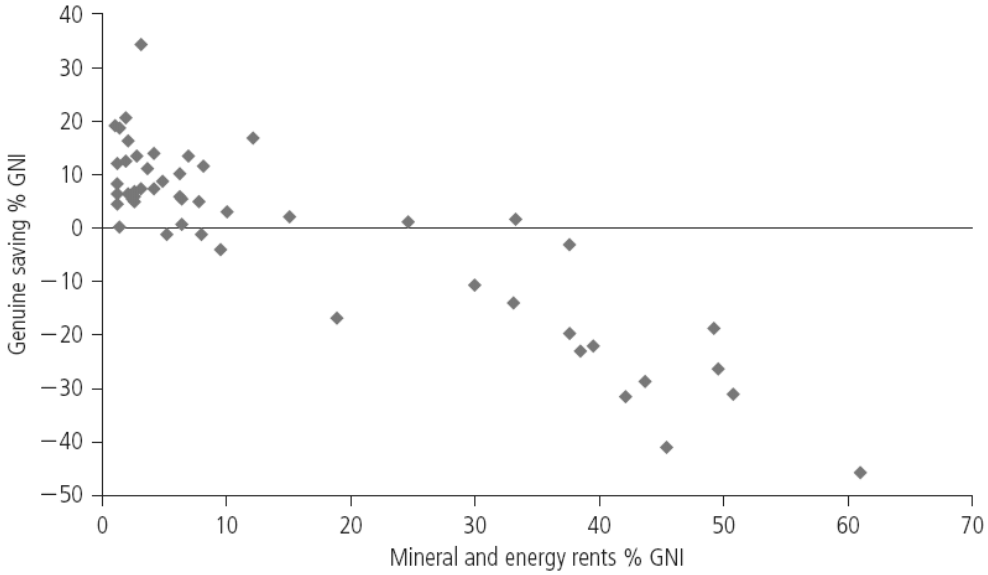
With the passing of time the relative productivity of the traded relative to that of the non-traded sector declines if the elasticity of substitution between traded and non-traded goods is less than unity. This shifts the equilibrium from A′ to A″ and eventually all the way to B. In the long run there is a real depreciation and the allocation of labour is returned to its original level.

**Figure 3: Rent grabbing and producer friendly institutions**



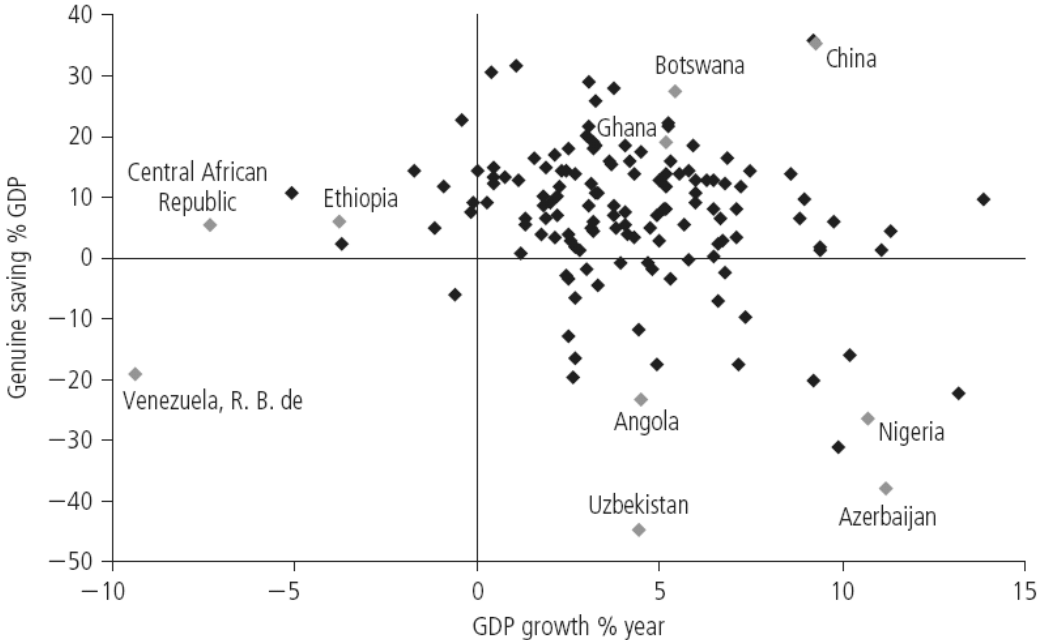

Key: A resource bonanza shifts equilibrium from A to A″ if there are strong institutions, which means higher profits and more entrepreneurs. In case of weak institutions the equilibrium shifts from A to A′, so profits decline and number of rent seekers increases.

**Figure 4: Genuine saving and exhaustible resource share**



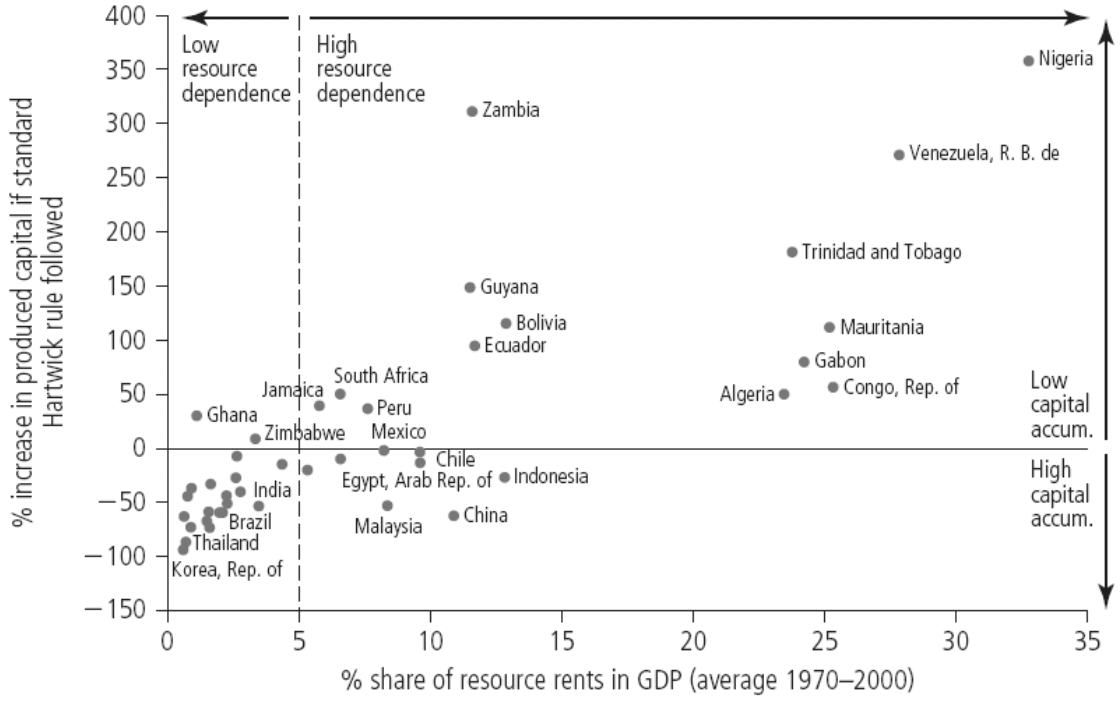

Source: World Bank (2006, Figure 3.4)

**Figure 5: Genuine saving rates against economic growth, 2003**




Source: World Bank (2006, Figure 3.6).

**Figure 6: Resource abundance and capital accumulation (Hartwick rule)**




Source: World Bank (2006, Figure 4.1).