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Bananas, Oil, and Development: Examining the Resource Curse and Its Transmission Channels by Resource Type

by

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Abstract:

This paper examines the resource curse and its transmission channels by resource type. We review and synthesize existing theories of the transmission channels of the curse. This synthesis suggests that (1) relating the transmission channels to the characteristics of different types of resources, and (2) considering how other country characteristics, such as institutional quality and policy outcomes, affect the impact of natural resource wealth on development, would improve our understanding of the functioning of the curse. We then assess these two aspects empirically and find different transmission channels to be relevant for different types of resources. Furthermore, we illustrate the interaction between other country characteristics and the curse.

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Introduction

Whereas early development economists were optimistic about the future prospects of resource-rich countries and regarded the lack of natural resources as a constraint to economic development[1], the experiences of many resource-rich countries, in particular since the 1980s, suggests the opposite, namely that resource-rich countries tend to develop much more slowly than resource-poor countries.

A wide range of explanations for the curse of natural resources has been found. There is evidence that resource-rich countries experience an unfavourable pattern of structural change and are exposed to higher macroeconomic volatility. Furthermore, the availability of large resource rents typically leads individuals to engage in unproductive rent-seeking activities and creates perverse political incentives that tend to produce misled policies. There are numerous examples of deficient political systems, corruption, and plunder in resource-rich countries. The following dispatches highlight some of the possible problems resource-rich countries face:

"Being confronted with criticism regarding corruption and plunder under the Marcos regime, Imelda Marcos, widow of the former Indonesian dictator, claimed that descriptions of her prodigious shoe collection were grossly exaggerated. 'I did not have 3,000 pairs of shoes, I had 1,060.'" (www.newint.org, September 2003)

"The soldiers may have decided to revolt due to their low salaries. Since the slump in cacao exports Sao Tomé is in deep economic crisis. Struggles between rivalling parties over recently discovered oil reserves may also have triggered the coup d'état."(Frankfurter Allgemeine Zeitung, July 17, 2003)

The "resource curse" or "paradox of plenty" has triggered a substantial amount of theoretical and empirical literature. Important theoretical contributions include the macroeconomics of a resource boom, the famous Dutch disease effect, the role of manufacturing-related externalities in economic development, and the reconciliation of these two strands of literature. In political science, the concept of the rentier state has been frequently used to describe the nature of the political systems in resource-rich countries. In addition, economists have attempted to capture the political economy of resource-rich countries in formal models. These contributions have sharpened the understanding of the transmission channels of the curse. Yet, we think that the numerous explanations of the resource curse have often been considered only separately, and many literature reviews just

[1] For example, in Nurske's account of reasons why countries remain poor (1967, p.5) the lack of mineral resources is listed second after the lack of capital.

itemise them without taking their interdependencies into account. Therefore, we consider it a worthwhile undertaking to synthesise the existing theories and illustrate their interdependencies. This synthesis has drawn our attention to two aspects of the curse that the theoretical literature to date has only considered rudimentarily. First, that certain transmission channels of the resource curse can be related to certain characteristics of the resource, and second that resources can be a blessing, too.

Empirically, the resource curse hypothesis has been tested using both cross-country and single-country studies. Cross-country studies have established that resource-rich countries grow more slowly than resource-poor countries, whereas single country studies have indicated how the curse works in a specific case. This paper is intended to fill three important gaps in the empirical cross-country literature on the resource curse. First, most of the literature is not very precise in defining and measuring natural resource abundance. Therefore, we consider different proxies for natural resource abundance and different types of resources in our regressions. Second, while the recent cross-country literature has improved our understanding of the resource curse through focusing on the transmission channels, it has done so without differentiating between different types of resources. However, it may well be that a specific transmission channel is linked to a resource with specific characteristics. Hence, we analyse the transmission channels of different resource types. Third, empirical research has shown that resource-abundant countries do not necessarily suffer from the resource curse. Indeed, there are quite a few countries whose development has been successfully based on natural resources. Depending on the resource type, different factors seem to influence whether the growth impact of resources is positive or negative. Thus, we examine what country characteristics determine the effect of different natural resources on growth.

The paper is structured as follows. In the first section of the paper, we first review and attempt to synthesise the theory of the resource curse and its transmission channels. Then, we reconsider the available evidence concentrating on cross-country studies. The second section presents the results of our own empirical work, in which we analyse the resource curse and its transmission channels by resource type. We investigate the impact of different resource types on growth, attempt to relate these resource types with specific transmission channels, and examine how country characteristics affect the influence of resource wealth on growth. The third section of the paper concludes and provides an outlook for future research.

The Resource Curse and its Transmission Channels: Theory and Evidence

Why Resources Turn Out to Be a Curse

The wealth of nations can be thought of as consisting of social, physical and human capital, and natural resources. Social capital includes political institutions, property rights arrangements, markets, the legal system, and informal institutions; physical and human capital are reproducible types of capital whereas natural resources, including land, water, forests, and subsoil assets, cannot be accumulated. In order to increase or sustain consumption in the long run, natural resource-based economies, i.e. economies that derive an important share of income from resource rents, will have to accumulate other forms of wealth; their social capital plays a key role in facilitating the conversion of natural resource into other forms of wealth.[2] If they fail to do so, they will eventually end up poorer than they were before the exploitation of their natural resources. Yet, one should always bear in mind that, in principle, natural resources augment a country's wealth.

Natural resource abundance does not only present a challenge to a country's institutional setup. The expansion of a resource-extracting sector as well as the flows of resource rents into the domestic economy also entail a pattern of long-run structural change that differs from most of today's developed countries.[3] This growth pattern may be associated with lower growth and policies intended to mitigate this effect have typically failed.

Furthermore, the wealth gains or losses related to natural resources are often of a windfall nature, triggered for example by sudden increases or decreases in commodity prices or the discovery of new resource reserves. Natural resource-abundant countries therefore frequently experience boom and bust cycles. Macroeconomic volatility alone may already harm growth prospects, but wrong policies may exacerbate this negative growth effect. The literature, in particular economic theory, has been relatively silent on the volatility-growth relationship.[4] Yet, some empirical work has investigated the impact of commodity price volatility on growth.[5]

The wise use of natural resource rents, structural policies, and the economic management of booms and busts thus pose formidable challenges to both private and public agents in resource-rich economies. Many countries have not been

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[2] See Hartwick (1977) and Vincent, Panayotou, and Hartwick (1997) for formal presentations of this problem in closed and open economies, respectively.

[3] For a comprehensive theoretical treatment of how endowments shape structural change see Leamer (1987). Wood and Berge (1997) and Wood (1999) compare and analyse the patterns of structural change of resource-poor versus resource-rich economies.

[4] See Ramey and Ramey (1995) for a discussion of the link between volatility and growth. Pallage and Robe (2003) examine this link for developing countries.

[5] See Dehn (2000) and Deaton (1999) on Africa.

able to solve the related problems and exhibit a mediocre growth record, thereby making resource abundance a curse rather than a blessing. In the following, we will examine the transmission channels of the resource curse, which explain why resource-rich countries often find it difficult to sustainably manage their economies, in quite some detail.

The quality of social capital, in particular of political institutions and the type of property rights arrangements, determines whether natural resource rents will be used for good. Yet, the evolution of institutional arrangements itself may well be negatively affected by natural resource abundance. Back in colonial times, political institutions and property rights regimes in many natural resource-rich economies have been set up to ensure the smooth exploitation of natural resources.[6] In such "extractive" colonies, institutions were shaped in a way that empowered the elite to extract minerals or plant cash crops. In contrast, institutions that supported private property were set up in settler colonies, which include the US, Australia, and New Zealand. In extractive states, secure property rights were only provided for the politically and socially powerful elite. The vast majority of the population had no effective property rights, not even civil rights, and hence faced a constant risk of expropriation. Such extractive institutions can endure since the powerful elites do not have incentives to opt for institutional changes. These changes might reduce the rents they obtain, are most likely to reduce their political power, and might produce no direct benefit for them. Acemoglu, Johnson, and Robinson (2002) mention two factors determining whether a colony would become a settler or extractive colony. First, the profitability of extractive institutions mattered, which of course was linked to the value of the resources that could be extracted.[7] A second factor was the possibility and feasibility of settlement (settlement policies, disease environment).

The evolution of institutions is of course path-dependent and in some cases such institutions, which may well be detrimental to development, endured after decolonisation. Of course and maybe more importantly, also in post-colonial times, natural resource abundance has shaped institutions and their quality, in particular those in the political domain.

Political institutions in resource-rich countries have frequently been described using the concept of the "rentier state", especially by political scientists. The concept of the rentier state goes back to Mahdavi (1970) who studied the problems of the Iranian economy in the 1960s. It is a theory about the nature of the state in economies that principally rely on rents from natural resources, in par-

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[6] See Acemoglu, Johnson, and Robinson (2002) and Easterly and Levine (2002) and the literature cited therein. This paragraphs summarises the main ideas of the "institutions hypothesis" from Acemoglu, Johnson, and Robinson (2002).

[7] In addition, a relatively high population density was required that provided a labour pool that could be forced to work in mining and agriculture. Furthermore, pre-existing institutions of corvée, tax administration, or tribute could have made it easier to set up extractive institutions.

ticular oil, as the concept has been mainly applied to the Arab world.[8] The state plays a dominant role in such an economy, as a large share of resource rents typically accrues to the government. Therefore, it does not have to tax the citizens, who in turn may not feel the need to control government action. The resulting larger degree of autonomy of the government tends to weaken the state and the lack of accountability may lead to corruption and plunder.

Political processes in the rentier state are mainly concerned with the distribution of resource rents in order to stay in power. The allocation of resource rents may thus be guided by purely political motives. In general, this may imply a tendency to overconsumption of resource rents (or even of overextraction of resources). In most cases, resource rents will not be transferred directly, but rather through subsidies, trade restrictions, or granting public sector employment. The state gets deeply involved in economic activities, which leads to major economic distortions and additional welfare costs (Auty and Gelb, 2001). In a rentier economy, a large part of the population is hence involved in distributing and consuming rents, whereas only a few engage in productive activities. Furthermore, resources are devoted to gain access to resource rents as well as to policy-induced rents. Individuals hence engage in rent-seeking rather than wealth creating activities, efficiency and dynamism in the economy suffer.[9]

Under specific circumstances, such as ethnic or religious fractionalisation, the political competition for resource rents may even result in civil war. In such a case, natural resource rents, for example from diamonds, may trigger open conflict and nourish it afterwards, as resource rents provide the financial means to maintain military forces.[10]

As may have become clear from the preceding paragraphs, the political economy of natural resources is multifaceted and the literature offers a wide variety of political and institutional explanations of the resource curse. However, these explanations are often only backed by anecdotal or country case evidence, which is why it is hard to single out the most important channels. It is therefore a very difficult, if not impossible task to summarise the most important political and institutional forces behind the resource curse. Yet, we have tried to capture the basic insights that emerge from the theoretical literature. We now turn to the more narrowly economic and economic policy dimensions of managing natural resource wealth.

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[8] See for example Mahdavy (1970) and Beblawi (1987) on Arab states, Shambayati (1994) on Turkey and Iran, and Yates (1996) on Gabon and other African states.

[9] There is a growing theoretical literature on the political aspects of the resource curse. Robinson, Torvik, and Verdier (2002) illustrate the costs of politically induced misallocations in a formal model. On the costs of rent-seeking to growth, see Krueger (1974) and Murphy, Shleifer, and Vishny (1993). Different mechanisms of how natural resource booms can lead to lower welfare in the presence of rent-seeking are reviewed in Torvik (2002).

[10] See the edited volume by Bannon and Collier (2003).

A characteristic feature of a typical "successful" development path is the growing importance of the manufacturing industry in the early stages of development (Chenery, Robinson, and Syrquin 1986). This sector exhibits important positive externalities, such as learning-by-doing effects or economies of scale in production. Resource-rich economies, however, specialize in sectors without these externalities, for example in agriculture or mining, with a negative impact on growth.[11] Additionally, many natural resource-based sectors have an enclave character without linkages to the rest of the economy (Hirschman 1958). Furthermore, a resource boom is often accompanied by a real appreciation that causes the manufacturing sector to shrink and the non-tradable sector to expand, a phenomenon labeled "Dutch disease" after the impact of natural gas discoveries in the Netherlands in the 1950s (Corden 1984; Neary and van Wijnbergen 1985). The possible negative effect on long-term growth is shown by Sachs and Warner (1995) in an extension of the Matsuyama (1992) model.

Some authors have argued that natural capital "crowds out" human capital.[12] The specialisation pattern of natural resource rich economies may be interpreted as the driving force behind this crowding-out effect. Industrialisation, i.e. the growth of the manufacturing sector, is typically accompanied by broad-based demand for medium-skilled workers. However, the sectors that often dominate resource-rich economies, the service and the resource sector, demand primarily low-skilled and only little high-skilled labour.

The resulting limited degree of diversification of resource-dependent economies is the major reason for the high macroeconomic vulnerability of these countries. Although the possible link between macroeconomic volatility and growth is not well established theoretically, it has been identified empirically as an additional obstacle to growth (Pallage and Robe 2003). In order to be able to manage resource booms and busts, governments and private agents need to anticipate the time nature of the shock. Such shocks can be transitory, as for example an increase in coffee prices due to weather shocks, or permanent, as for example the discovery of natural gas reserves. In case of a transitory shock the government would want to smoothen the shock and prevent it from having a long-term negative impact. Permanent shocks, however, require structural adjustments. These adjustments can be very costly in social terms in case of a permanent negative shock, e.g. through generating unemployment.

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[11] Matsuyama (1992) illustrates this effect in an endogenous growth model with externalities in the manufacturing sector.

[12] Gylfason (2001) argues that resource-rich countries concentrate on natural resources as their most important asset, thereby neglecting the development of their human resources. He states that "their natural wealth may blind them to the need for educating their children." Although there may be some truth in this statement, in particular with regard to countries under authoritarian rule, we think that the transmission mechanisms are more subtle.

However, the problem following windfall gains and losses is not only the choice of the right policy instruments to smooth out temporary shocks or the management of long-term structural adjustment. Often, expectations about the nature of the shock are wrong. Whereas positive transitory shocks are considered to be permanent, negative permanent shocks are perceived as only temporary. In the first case, the case of myopic expectations, this leads to changes in economic structures that require costly adjustments that could have been avoided, had the windfall gain rightly be judged as temporary. In the second case, necessary structural adjustment is delayed, which may make future adjustment significantly more costly. Wrong expectations about the time nature of the windfall gains and losses or myopic behaviour may thus aggravate the boom and bust cycles related to natural resources.

But even if shocks are rightly considered permanent or temporary, windfall gains or losses require wise economic management. Inadequate policy responses may be more important in causing economic underperformance than the economic consequences of booms and busts alone. An example of wrong policy responses is that resource booms typically lead to excessively increased public sector spending. There are three areas of public spending, which are likely to benefit most from this increase. First, increasing public employment is an attractive short-term policy instrument to reduce underemployment and unemployment. Second, higher public investment often goes into projects with lower than market returns or construction, as investment opportunities are frequently limited. Third, the government may be tempted to promote import-substituting or other than resource-based export-oriented industries through subsidies. As expenditure cuts in all these areas are often not politically feasible, the government may run into debt problems once the resource boom comes to an end. Wrong policies might also be chosen in monetary matters. For example, high inflation could be the result of central banks' inability to sterilise the impact of the resource boom induced foreign exchange inflow on money supply. Such wrong policy responses to booms and busts have to be interpreted against the background of the special political economy of natural resource-rich countries, of which some major features have been outlined above.[13]

Resource booms are often triggered by terms of trade shocks, i.e. by sudden increases in the prices of natural resources or commodities. Two characteristics of the price behaviour of commodities can be thought of as being detrimental to development. First, the short to medium-term volatility of commodity prices causing terms of trade shocks and, second, the long-term decline in the terms of trade of natural resource exporters. The short and medium term price volatility is the root cause of many of the policy failures outlined in the preceding paragraph. In addition, institutional failures may hinder private agents to respond ade-

[13] Examples and case studies of wrong (and right) policy responses to resource booms are documented in Neary and van Wijnbergen (1985), Gelb et al. (1988), and Collier and Gunning (1998a and 1998b).

quately to resource booms and busts. For example, cash crop farmers in developing countries often lack access to credit markets, which prevents them from saving a share of the windfall profits. Furthermore, the fiscal dependence on resource rents typically aggravates the effects of a negative price shock.

Natural resources have often been claimed to be subject to Engel's law, i.e. demand and thus their relative price would fall with rising incomes. Supposedly, natural resources thus exhibit lower income elasticities of demand than manufactured products. In addition, northern manufacturers have been blamed to exercise market power on commodity markets and force down prices.[14] Therefore, resource-based economies do not only go through boom and bust cycles, they also face a steady decline in the relative price of their export products. This means that the net barter terms of trade of resource-exporting and manufactures-importing countries tend to fall. Without a compensating increase in resource export volumes, the income terms of trade will fall accordingly, which, besides having a direct negative welfare effect, also limits growth prospects, as it reduces the ability to import capital goods.

The abovementioned political and economic channels through which natural resource abundance affects development are of course interrelated. An important dimension of this interrelatedness is the interplay of political institutions, policy choices, and economic outcomes. Consider for example the Dutch disease and government expenditure policies. Government expenditure policies can be a crucial factor in causing Dutch disease effects. If we do not see the political economy behind expenditure policies, we will hence not fully understand the origin of the Dutch disease problem.

The Oil and the Banana Curse Are Different

We think that it would improve our understanding of the resource curse if more attention was paid to the characteristics of different types of resources and how these characteristics are related to the transmission channels of the curse. The resource curse literature has little to say in this regard. Auty (2001) differentiates between "point" and "diffuse" resources where point rents are associated with staples that require relatively capital-intensive extraction methods implying concentrated ownership. Point resources are typically mined, but cash crops that are immediately processed, such as sugar cane, also fall under this category. Rents of diffuse resources, for example from rice, maize, and some tree crops, are more widely dispersed among the population, as they do not require a comparable capital input. According to Auty (2001), this difference in resource characteristics explains why point resource-rich countries have been hit harder by the resource curse.

[14] See Deaton and Laroque (2003) and the literature cited therein.

Of course, it makes a difference for economic development whether an economy is abundantly endowed with land, timber resources, metals, oil, diamonds or other resources. Even if all the resource-abundant countries share the feature of having underperformed in terms of economic growth: The oil curse may well function different from the banana curse. Auty's (2001) categorisation points to two resource-specific aspects that are relevant for the strength of the different transmission channels of the curse; (1) the technology needed for the production of the resource, and (2) the degree of rent dispersion. There are at least three more aspects to be added; (3) the potential of forward and backward linkages and integrating into global value chains, (4) the feasibility of rent appropriation through state institutions, and (5) the long-term trends in commodity prices and the degree of price volatility.

The potential of forward and backward linkages of many resource sectors, in particular agricultural sectors, has changed in a globalising world economy with increasing factor mobility. Consequently, a greater share of final product value is added in resource-rich developing countries. Many agricultural products as well as some metallic ores and oil offer good opportunities for developing forward and backward linkages and integrating into global production.

The feasibility of rent appropriation through state institutions is a crucial factor determining through which channels resource wealth affects development. As the literature reviewed above suggests, the presence of resource rents has a profound impact on the evolution and the functioning of political systems. Some resource rents can be relatively easily appropriated, for example by taxing away the rents from oil and gas. Yet, other resource rents, in particular those originating in cash crop sectors, require more sophisticated and possibly more distortionary measures. A case in point are the marketing boards for agricultural export products.[15]

Different types of resources exhibit different price trends and different degrees of short-term price volatility. Overall, the behaviour of commodity prices in both the short and the long-run is still not fully understood (Deaton and Laroque 2003). Besides the explanations given above, long-run commodity price trends reflect permanent demand shocks, such as changes in tastes and technological progress, and permanent supply shocks, for example new extraction technologies. Factors behind short-term commodity price volatility are business cycles in importing countries, the behaviour of speculators, and transitory shocks, such as weather shocks or political events. Both long-run and short-run determinants of price movements differ between different types of resources.

[15] These marketing boards have been subject to a wave of reforms in many developing countries. See Akiyama et al. (2003) for an overview of African cases.

Resources Can Be a Blessing, Too

However, natural resource abundance (even of the same resource) has not always proved a curse. Besides the disappointing or even devastating development trajectories of Sierra Leone, Bolivia, and Venezuela, there are also success stories of resource-based development, for example in Botswana, Chile, and Indonesia. This suggests that there is an important interplay between resource-abundance and other country characteristics, in particular the quality of institutions and economic policies. Often, this interplay gives rise to virtuous or vicious circles grounded in initial circumstances. On the one hand, as described above, institutions as well as policies are affected by the availability of natural resource rents. On the other hand, the deployment of the rents for good or for bad depends on the quality of institutions and policies.

This has of course been noted in the empirical literature, but the theoretical literature has not paid much attention to this interplay with the notable exception of the political economy model of Robinson, Torvik, and Verdier (2002). They show that countries with good institutions benefit from a resource boom, since perverse political incentives are mitigated, whereas countries with bad institutions are hit by the resource curse. If the resource curse mainly works through wrong policy responses, a similar reasoning would apply to good policies as a means to overcome the resource curse (obviously good institutions and good policies are often highly correlated).

Evidence

Three lines of empirical research on the resource curse can be distinguished. First, there are single country studies, as for example the collections of case studies in Auty (2001) and Mayer et al. (1999). Second, the literature analyses a number of specific transmission channels of the resource curse. For example, real exchange rate behaviour, related sectoral shifts (Dutch Disease), and the fiscal linkage, in particular government spending pattern, in response to the oil windfalls of the 70s and 80s are studied in Gelb et al. (1988). Along similar lines, the case studies in Collier and Gunning (1998a and 1998b) focus on construction booms and savings response during a resource boom. The link between commodity prices and growth is examined by Deaton (1999) and Dehn (2000). Political scientists, but also economists, have examined, often in quite some detail, the political dimensions of the resource curse.[16] Third, there are a number of cross-country studies on the resource curse. As our paper follows this third strand of literature, we will shortly review some of the main contributions.

[16] See Ross (1999) for an overview of the political science literature. Ascher (1999) contains a number of small case studies on institutional, political, and policy failure. Ross (2001) examines empirically whether oil hinders democracy.

Although there exists a considerable amount of cross-country studies on the resource curse, the analysis of the transmission channels has been largely neglected. Most of this empirical work has focused on single transmission channels, in particular on institutional quality, whereas macroeconomic volatility and economic policy have been less examined, which might partially be due to the fact that Dutch disease effects, which usually are policy-related, are difficult to account for in a cross-country regression framework.

Still, the work of Sachs and Warner (1995, 1997), who were the first to econometrically show the negative effect of natural resources on growth in a cross-section of countries, is the most influential one. Using a number of different aggregate proxies for natural resource intensity, they show that the negative growth effect of natural resources is very robust and cannot be explained by trade policy, human and physical investment, changes in the terms of trade, government expenditure ratios or institutions. In a more recent study (2001), they further demonstrate that resource-abundant countries tend to be high-price economies and therefore fail to benefit from export-led growth.

Lederman and Maloney (2002) revisit the results of Sachs and Warner (1997). They find that the results of Sachs and Warner cannot be recovered if different time periods are considered and endogeneity is accounted for. They speculate that the negative impact of natural resources on growth can probably be explained by unobserved country-specific effects. Yet, the strength of their findings seems to be limited due to the specification of their growth regressions. In the test of time, they consider seven different time periods ranging from 1820 to 1989. Data unavailability, however, forces them to regress with the share of primary exports in GDP in 1970 for all time periods meaning that in the extreme case 150 years lie between the data on growth rates and natural resource intensity. In addition, their sample only covers between 19 and 37 countries. Regarding endogeneity and country-specific effects, their growth regression already include possible transmission channels of the resource curse, such as the degree of openness and changes in the terms of trade, which makes it difficult to believe that there is really no negative effect of natural resources on growth. For these reasons, their study is rather to be seen as a theoretical contribution which warrants caution in the econometric analysis of the resource curse.

Stijns (2001) distinguishes between different types of natural resources. In addition to the share of primary exports in GDP, he also uses the reserves of land, oil, gas, coal, and minerals as proxies for resource abundance. He finds land to be the only reserve to have a robust and negative impact on growth, which lets him conclude that whether natural resources turn out to be a curse or a blessing depends on what countries do with them. In a second step, he analyses through which channels natural resources affect growth. He shows that land abundance consistently correlates with a poor quality of institutions and bad economic policies. In contrast, reserves of oil, gas, and minerals are positively correlated with education, quality of institutions, savings and investment rates, and market-

oriented economic policies. However, he detects Dutch disease effects for oil and gas, but not for minerals. The evidence is mixed for coal. Reserves of coal are associated with more market-oriented economic policies and higher savings and investment rates. With regard to education, institutions, and Dutch disease effects, no clear conclusions can be drawn. A weakness of Stijns' analysis of the transmission channels is that he only makes use of partial regressions. Thus, he does not control for other important determinants of growth, such as the level of GDP or investment rates.

Papyrakis and Gerlagh (2004) examine the resource curse with an explicit focus on the transmission channels. Their main finding is that the negative indirect effects of natural resources via the transmission channels on growth by far outweigh the positive direct effect of natural resource abundance. They consider a decrease in investment, a low degree of openness, and deteriorating terms of trade to be the most relevant problems of resource-abundant economies. Their study, however, is of less significance for the developing world as the sample consists of only 39 countries, the majority of them being OECD countries.

Besides this more or less general empirical literature, quite a few papers focus on the institutional transmission channel of the resource curse in a cross-country framework. By differentiating between point-source, coffee and cocoa, and diffuse natural resources, Isham et al. (2003) show that the dependence on point source resources and coffee and cocoa, in contrast to diffuse resources, negatively affects institutional quality which in turn is strongly associated with slower growth. Sala-i-Martin and Subramanian (2003) make use of the four resource categories provided by the World Bank's World Development Indicators (WDI; food, agricultural raw materials, fuels, and ores and metals) and present similar findings. Fuel and ores and metals, i.e. the point source resource types, are found to have a robust negative effect on growth via their detrimental impact on institutional quality.

Mehlum et al. (2002) and Boschini et al. (2003) demonstrate that institutions are decisive for the effect of natural resources on growth, as countries with good institutional quality can profit from their resource abundance, whereas countries with poor institutional quality are likely to suffer from the resource curse. Boschini et al. (2003) further show that the more appropriable the rents of a resource type are, the more important institutional quality is to avoid the resource curse.

One of the few studies analysing the economic policy channel of the resource curse was carried out by Atkinson and Hamilton (2003). They find the government's use of resource rents to be a crucial factor in determining the growth effect of natural resources. They present evidence that resource abundance has not been a curse for countries which have used resource rents to finance public investment whereas it has indeed been a curse for countries which have rather consumed their resource rents. In addition, those countries which have suffered

from the resource curse and have poor institutional quality appear to have low or negative genuine savings.

Gylfason and Zoega (2001) report that natural resource abundance correlates with low investment and savings rates, which they partially explain by the slow development of the financial system in resource-rich economies. They conclude that natural capital crowds out physical capital thus limiting growth. In another paper, Gylfason (2001) extends this crowding-out effect to human capital.

To sum up, the negative relationship between natural resources and growth is an established fact in the cross-country literature. Studies have shown that rather point-source resources seem to account for the resource curse. It has also been demonstrated that the growth effect of natural resources depends on institutional quality and the government's use of resource rents. Regarding the transmission channels, there is slight evidence that a deterioration of the terms of trade and institutional quality, low investment and savings rates, a low degree of openness, and poor human capital can partially explain the resource curse.

The Resource Curse by Resource Type: An Empirical Investigation

The Resource Curse by Resource Type

In this section we analyse the impact of different types of natural resources on economic growth in the period 1980-2000. We base our analysis on the conditional convergence hypothesis and use Barro-style (1991) cross-country regressions controlling for initial income and average investment rates. Our growth equation has the following form:

$$g_i = \alpha + \beta_{gdp} gdp_{1980,i} + \beta_{inv} inv_i + \beta_{NR} NR_i + \varepsilon_i \qquad (1)$$

where g_i denotes the geometric mean of the annual growth rates in country i in the years 1980-2000. The first explanatory variable is $gdp_{1980,\,i}$, the logged GDP per worker in country i in 1980. According to the conditional convergence hypothesis, we expect β_{gdp} to have a negative sign meaning that high-income countries have lower growth rates than low-income countries. Our second variable, inv_i, accounts for the average investment rate in country i between 1980 and 2000. Following the growth literature, we expect a positive impact of capital accumulation on growth, i.e. a positive sign for β_{inv}. Finally, our variable of interest, the measure of natural resource intensity in country i, is represented by NR_i, which is also averaged over the period 1980-2000. The resource curse implies a negative sign for β_{NR}.

To account for the diversity of natural resources we use a wide range of aggregate and disaggregate measures of resource abundance. The first column of Ta-

ble 1 gives an overview of our set of NR_is. Basically, we distinguish between reserves and the production of natural resources.

Reserves are calculated in per capita terms and include land, arable land, natural capital, and reserves of oil and natural gas in 1982. Data on land and arable land are from the World Bank's WDI. Estimates of a country's natural capital, which comprises the sub-groups pastureland, cropland, timber resources, non-timber resources, and subsoil assets, are from a World Bank report (1997). Data on oil and natural gas reserves are taken from the British Petroleum's Statistical Review of World Energy (2003).

Regarding the production of natural resources, data are scarce and not very trustworthy. For this reason, we use export-based measures to proxy this variable as the export values of different types of natural resources are widely documented according to standardised rules.[17] We follow Sachs and Warner (1995) and use two distinct proxies for the production of natural resources: the share of resource-based exports in GDP and merchandise exports (ME). In doing so, we are able to distinguish between the possibly different growth effects of a country's dependence on natural resources with respect to income generation (i.e. high share of primary exports in GDP) and foreign exchange inflow (i.e. high share of primary exports in ME). To capture non-linear relationships between natural resources and growth, we also use logged values of all NR_i measures as regressors.

Two different data sources are used for the production of natural resources: the World Bank's WDI and the United Nations Commodity Trade Statistics Database (Comtrade). In addition to an aggregate measure of resource-based exports, the WDI also provide data on four relatively broad subgroups: food, agricultural raw material, fuels, and ores and metals.

Comtrade data, however, are available for each SITC category thus allowing us to form much more detailed subgroups which we divide into different aggregation levels. Aggregation level one, the most aggregate level, only contains an aggregate measure of all primary exports. At aggregation level two, we distinguish between the three subgroups agricultural products, wood and paper, and minerals, metals and fuels which we further disaggregate into non-processed and processed natural resources at aggregation level three. We continue disaggregating until a fairly specific resource type can be identified. A detailed description of all variables can be found in the appendix.

All regressions are run using Ordinary Least Squares with White-corrected standard errors. Despite its imperfectness, this method provides informative esti-

[17] Sachs and Warner (1997) also prefer export-based proxies to actual production data as they expect fewer gross measurement errors. Regarding data on the production of natural resources, they write that for developing countries these data are "simply not recorded or contain obvious guesses".

mates which allow us to collect some stylised facts about the resource curse and its transmission channels.

Table 1 reports the regression results. To improve the clearness, the table does not include the estimated parameters of $gdp_{1980,\,i}$ and inv_i. Both, however, show the expected sign and are usually significant at the one percent level. In very few cases, the parameter of $gdp_{1980,\,i}$ is only significant at the ten percent level. As indicated by the adjusted R^2s (between 0.33 and 0.52), our growth equations explain a satisfactory amount of the variation in the dependent variable.

A natural resource accounts for the resource curse (blessing) when it has a negative (positive) effect on growth and is significant at the ten percent level. Although all measures of NR_i are standardised, β_{NR} should be interpreted rather by sign than by value at the more disaggregated levels since a few countries excessively abundant in the respective resource strongly influence the value in many cases.

Two measures of natural resource reserves turn out to negatively influence growth: land and non-timber forest resources. However, we do not believe that this finding is consistent with the resource curse hypothesis. The negative coefficient of land per capita should be interpreted with caution as it is the inverse of population density.[18] One can rather imagine that land per capita proxies other geographical factors which impede growth. In particular, we can think of the absence of agglomeration effects or infrastructural problems hampering growth in land-abundant countries. In the case of non-timber forest resources which measure forests' externalities, our doubt is founded on the fact that this resource is intangible and therefore not susceptible to rent extraction.

In contrast, other reserves, including subsoil assets and oil and natural gas reserves in 1982, do not play a significant role in explaining growth.

As expected, we find the resource curse to be present in the period 1980-2000 when we use the aggregate export-based proxies for natural resource abundance. Three out of our four aggregate measures have a significantly negative effect on growth: primary exports WDI (GDP, ME)[19] and primary exports Comtrade (ME). The coefficients indicate that a high share of primary exports in merchandise exports is worse for growth than a high share of primary exports in GDP. This result supports our assumption that the impact of primary exports (ME) differs from the impact of primary exports (GDP).[20]

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[18] Compare Stijns (2001).

[19] In the following, GDP (ME) indicates that resource intensity is measured as the share of primary exports in GDP (merchandise exports).

[20] Considering, however, that the share of primary exports (GDP) is always smaller than the share of primary exports (ME), this finding may not hold true as on average a certain share of primary exports (ME) corresponds to an accordingly lower share of primary exports (GDP).

At the disaggregated level, the regression results for NR_i are more ambiguous: Many proxies for both agricultural and mineral resources do not have a significant impact on growth[21], whereas others negatively or positively influence growth.

[21] One could argue that this is partially explicable by the level of disaggregation. The higher the level of disaggregation is, the lower is the share of a resource in GDP or ME. At a certain level of disaggregation, this share would only be of minor importance for GDP or ME. Thus, one could not expect the respective resource to be a reasonable determinant of a country's growth rate. Nevertheless, we think that by and large our levels of aggregation are sufficient to be of relevance for growth. As the results show, even resources of aggregation level 5 (meat, dairy products and eggs, and fish) have a significant impact on growth.

Table 1: The impact of different types of natural resources on growth

	Reserves					
	linear			*logged*		
NR_i	β_{NR}	*t-value*	*N*	β_{NR}	*t-value*	*N*
Land	-0.24	-0.28	119	*-0.21***	-2.01	119
Arable land	-0.61	-0.67	119	-0.18	-1.49	119
Natural capital	0.53	0.75	73	0.19	0.92	73
Pastureland	1.47	1.03	90	0.04	0.30	90
Cropland	0.09	0.12	90	0.06	0.30	90
Timber resources	0.19	0.43	88	-0.11	-0.96	79
Non-timber forest resources	-0.10	-0.13	89	*-0.17**	-1.68	83
Subsoil assets	-0.73	-0.97	75	-1E-03	-0.01	64
Reserves of oil 1982	0.33	0.35	118	-0.02	-0.11	34
Reserves of natural gas 1982	-0.38	-0.43	117	-0.15	-0.91	32

	Share of primary exports in GDP					Share of primary exports in ME				
	linear		*logged*			*linear*		*logged*		
NR_i	β_{NR}	*t-value*	β_{NR}	*t-value*	*N*	β_{NR}	*t-value*	β_{NR}	*t-value*	*N*
Primary exports (WDI)	*-1.98**	-1.82	*-0.29**	-1.92	110	*-2.36****	-3.45	*-0.79****	-3.02	112
Food	1.18	0.35	0.12	0.95	110	0.06	0.07	0.13	1.05	112
Agricultural raw materials	-2.76	-0.48	0.08	0.96	110	0.52	0.51	0.04	0.39	112
Fuels	-1.31	-1.03	0.01	0.17	110	*-0.90**	-1.92	-3E-04	-0.01	112
Ores and metals	*-6.76***	-2.02	*-0.17***	-2.27	110	*-2.53***	-2.14	*-0.21***	-2.25	112
Primary exports (Comtrade)	-0.55	-0.45	-0.12	-0.78	112	*-2.25****	-3.14	*-1.02****	-2.94	114
Agricultural products	-0.75	-0.26	0.07	0.54	112	-0.49	-0.72	0.02	0.13	114
Non-processed agricultural products	-4.96	-0.58	0.05	0.65	112	-1.51	-0.91	0.01	0.09	114
Live animals	25.48	0.43	*0.11***	2.20	112	0.86	0.22	*0.09**	1.74	114
Cereals	33.71	1.02	*0.26****	3.28	112	5.34	1.08	0.10	1.01	114
Vegetables and fruit	-12.93	-1.26	0.01	0.16	112	*-3.92***	-1.99	-0.02	-0.21	114
Crude animal and vegetable materials	56.81	1.41	0.06	0.79	112	4.94	1.07	0.02	0.27	114
Processed agricultural products	4.11	0.72	0.11	1.12	112	-1.38	-0.91	0.05	0.47	114
Animal products	5.58	0.63	*0.28***	2.56	112	0.10	0.06	*0.26****	2.47	114
Meat	29.53	1.21	*0.14****	2.75	112	1.89	0.44	*0.11***	2.01	114
Dairy products and eggs	49.46	1.29	*0.14***	2.06	112	5.18	0.73	0.09	1.13	114
Fish	-4.14	-0.39	*0.12***	2.17	112	-1.14	-0.50	*0.13***	2.15	114
Hides and skins	-30.99	-0.87	-0.02	-0.25	112	0.60	0.09	-0.05	-0.69	114
Beverages	2.73	0.08	0.02	0.27	112	-12.21	-1.06	0.01	0.09	114
Animal and vegetable oil and fats	2.80	0.47	0.05	0.89	112	-1.76	-0.42	-0.02	-0.24	114
Other processed agricultural products	6.93	0.43	0.10	1.14	112	-10.81	-1.51	-0.03	-0.24	114
Cash crops	-2.75	-0.56	-0.02	-0.24	112	-0.36	-0.36	-0.02	-0.19	114
Sugar	16.09	1.50	0.06	0.72	112	*8.25****	4.19	0.09	0.97	114
Coffee	-8.62	-0.94	*-0.09**	-1.81	112	-1.31	-1.03	*-0.09**	-1.94	114
Cocoa and chocolate	-6.35	-0.88	-0.01	-0.10	112	-1.15	-0.50	-0.03	-0.44	114
Tea	13.24	0.60	*0.09**	1.81	112	-0.80	-0.21	*0.09**	1.95	114
Spices	-13.96	-0.58	0.10	1.49	112	-2.91	-1.49	0.09	1.31	114
Tobacco	-4.88	-1.47	0.04	0.55	112	-0.89	-0.77	0.06	0.68	114
Oilseeds	*-31.95***	-2.23	0.03	0.58	112	*-1.48***	-1.99	-3E-03	-0.07	114
Rubber	2.78	0.07	-0.03	-0.52	112	-14.11	-0.52	-0.04	-0.65	114
Textile fibres	-12.78	-1.63	0.04	0.58	112	-0.55	-0.57	-0.06	-0.61	114
Wood and paper	-4.17	-0.56	-0.04	-0.82	112	-0.22	-0.26	-0.08	-1.40	114
Minerals, metals and fuels	-0.43	-0.31	-0.02	-0.27	112	*-1.06**	-1.88	-0.14	-1.06	114
Non-processed minerals and metals	-2.88	-1.24	-0.06	-0.70	112	*-2.14***	-2.03	-0.09	-0.83	114
Crude minerals	*-22.60****	-3.25	0.06	1.13	112	*-4.29****	-2.73	0.04	0.70	114
Metalliferous ores	-0.66	-0.38	-3E-03	-0.05	112	-0.49	-0.47	0.01	0.18	114
Non-ferrous metals	*-8.58**	-1.80	-0.02	-0.20	112	*-3.76***	-2.14	-0.05	-0.54	114
Iron and steel	-3.77	-0.21	0.09	1.10	112	-3.93	-0.72	0.08	1.01	114
Processed minerals and metals	*7.19****	7.22	*0.23***	2.58	112	*2.84****	2.70	0.16	1.58	114
Mineral fuels	-0.99	-0.64	0.02	0.33	112	-0.72	-1.30	-0.01	-0.25	114
Coal	*82.81**	1.87	0.04	0.64	112	10.97	1.60	0.03	0.46	114
Petroleum	-0.97	-0.62	0.01	0.16	112	-0.74	-1.27	-0.03	-0.39	114
Gas	-9.51	-0.93	0.01	0.22	112	-3.24	-1.48	-4E-03	-0.08	114

*/**/*** indicate that NR_i is significant at the 10/5/1 percent level. *Cursive and underlined* figures denote a resource curse, only *cursive* figures a resource blessing. WDI = World Development Indicators, Comtrade = United Nations Commodity Trade Statistics Database.

Source: Authors' calculations.

The agricultural resources which seem to be detrimental to growth include vegetables and fruit (ME), coffee (GDP, ME), and oilseeds (GDP, ME). As the effect of vegetables and fruit (ME) is considerably influenced by Latin American exporters of banana, we include a dummy for this region.[22] The inclusion of the dummy, however, does not affect the negative impact of vegetables and fruit (ME) in a significant way.

Still, there are other agricultural resources which positively contribute to growth: live animals (GDP), cereals (GDP), a number of processed animal products (GDP, ME), sugar (ME), and tea (GDP, ME). Interestingly, tea and coffee have completely reverse effects on growth. To ensure that tea and coffee do not operate as regional proxies for Asia and Latin America respectively, we include dummies for these regions in the corresponding growth equations. Our results, however, do not change notably.

Among the mineral resources, we find fuels (ME), non-processed minerals and metals (ME), crude minerals (GDP, ME), and non-ferrous metals (GDP, ME) to hamper growth. The finding for fuels (ME) also holds true after the inclusion of a regional dummy for the Middle East and North Africa. Yet, for processed minerals (GDP, ME) and coal (GDP), we detect growth-enhancing effects.

On the basis of these regression results, we can draw two major conclusions. First, reserves of natural resources per se do not impede growth. It is rather the production of natural resources which is harmful to growth. Second, the growth impact of natural resources substantially depends on the resource type. Our findings cannot support the established assumption that abundance in point-source resources, which are typically associated with mineral resources, slows down growth whereas abundance in diffuse resources, which are usually associated with agricultural resources, favours growth. We find evidence that other factors, e.g. the need for further processing, also determine the growth effect of a natural resource. This is perfectly illustrated by the reverse effects of non-processed and processed minerals.

To check the robustness of our results, we exclude OECD countries from our sample to diminish the probability that NR_i is a proxy for an omitted variable related to the stage of development. The changes in the regression results (not reported), however, are negligible. Thus, the above described effects of natural resources on growth remain valid.

[22] As in the case of vegetables and fruit, a considerable amount of the production of certain types of natural resources is concentrated in a specific region. Therefore, it may well be that in such a case, NR_i serves not only as a proxy for natural resource intensity but also for unobserved region-specific effects including political, economic, social, cultural, and geographical factors. To ensure that NR_i only covers natural resource intensity, we include a regional dummy which accounts for the region-specific factors. Of course, this method is far from being perfect since to a certain extent the regional dummy will always include the region's endowment of the measured natural resource. This, however, would bias the results against our findings so that we are on the safe side using regional dummies.

The Transmission Channels of the Resource Curse

For analysing the transmission channels of the resource curse, we specify a new growth equation:

$$g_i = \alpha + \beta_{gdp} gdp_{1980,i} + \beta_{inv} inv_i + \beta_{NR} NR_i + \beta_{TC} TC_i + \varepsilon_i \qquad (2)$$

where TC_i denotes possible transmission channels. When adding variables representing transmission channels to equation (1), we expect these controlling variables to drive down the estimated coefficient of NR_i as they should explain some of NR_i's negative effect on growth. For the same reason, we also expect that NR_i is less significant after controlling for transmission channels. Accordingly, a transmission channel is identified when NR_i is no longer significant at the 20 percent level and its coefficient β_{NR} is smaller after the inclusion of potential transmission channels.

Our ten variables used to identify the transmission channels can be seen as proxies for three broad areas: macroeconomic vulnerability, institutional quality, and economic policy. Macroeconomic vulnerability is described by terms of trade and growth volatility. Institutions, economic freedom, and property rights constitute institutional quality. Finally, economic policy is proxied by inflation, average tariff rates, the openness index by Sachs and Warner, public investment, and secondary education. A detailed description of these variables and their sources can be found in the appendix.[23]

When adding the transmission channels to the growth equation, two problems arise. First, multicollinearity makes it impossible to draw a sharp distinction between the explanatory powers of different transmission channels. As can be seen in Table 2, the correlation between most variables used to identify potential transmission channels is quite high. Correlation is especially high within the area of institutional quality and between the areas of institutional quality and economic policy.

[23] Unfortunately, we cannot find a meaningful way to examine Dutch disease effects in our growth regressions. Even in other estimation frameworks, these effects are hard to examine. Sachs and Warner (1997) present evidence that natural resources significantly decrease the export share of manufactures and increase the ratio of services to manufactures output. In a more recent paper (2001) they further show that due to the higher prices in the non-traded sector resource-abundant countries have a higher general price level. In their econometric analysis, however, they do not establish a direct link between these effects and growth.

Table 2: Correlation matrix of the variables identifying possible transmission channels

	Macroeconomic vulnerability		**Institutional quality**			**Economic policy**				
	Terms of trade volatility	Growth volatility	Institutions	Economic freedom	Property rights	Inflation	Average tariff rates	Sachs and Warner openness index	Public investment	Secondary education
Terms of trade volatility	1.00									
Growth volatility	0.11	1.00								
Institutions	-0.18	-0.35	1.00							
Economic freedom	-0.18	-0.43	0.71	1.00						
Property rights	-0.09	-0.29	0.71	0.83	1.00					
Inflation	0.51	0.29	-0.39	-0.19	-0.25	1.00				
Average tariff rates	-0.05	-0.35	0.59	0.72	0.51	-0.13	1.00			
Sachs and Warner openness index	-0.06	-0.29	0.65	0.76	0.69	-0.35	0.64	1.00		
Public investment	0.11	0.16	-0.35	-0.44	-0.38	0.08	-0.42	-0.36	1.00	
Secondary education	-0.08	-0.46	0.66	0.70	0.59	-0.24	0.52	0.62	-0.25	1.00

Source: Authors' calculations.

Second, due to limited data availability, the consideration of many transmission channels at the same time would dramatically reduce our sample size and thus limit the validity of our findings. If we included all variables representing potential transmission channels in equation (2) simultaneously, our sample size would almost be halved: only 63 out of 119 countries would remain in the sample.

For these two reasons we check for only one transmission channel in each regression. In doing so, we can much better distinguish between the effects of different transmission channels and keep the sample large.

Controlling for only one transmission channel, however, cannot fully circumvent that the sample size is decreased. Depending on the variable, we loose up to 26 observations. To ensure that the resource curse for the different natural resources[24] still exists in the reduced samples, we adjust the sample size to the respective transmission channel before its inclusion into the growth equation. Now, we allow NR_i to be significant only at the 15 percent level since the previ-

[24] In the following, the term "natural resources" will only denote those resources which have been identified as a curse in the preceding section.

ous section has already proven their negative effect on growth at the ten percent significance level.

As it turns out, in a few cases the resource curse does not survive this kind of robustness check. In the case of non-timber forest resources, only three missing countries (Mauritius, Togo, and the Central African Republic) make the resource curse disappear when adjusting the sample to the variables economic freedom or property rights. The same applies to oilseeds but this time owing to four missing countries (Mauritius, the Central African Republic, Togo, and Guinea-Bisseau). As a very small number of countries seems to drive the results, we must qualify our findings for these two natural resources. In all other cases, however, changes as a result of the sample adjustment are caused by a much larger number of countries ($n \geq 11$) so that there is little reason to modify our earlier findings.

Our regression results for the transmission channels are displayed in Table 3. The results indicate that different resource types are related to different transmission channels. For many natural resources, however, we do not detect any transmission channel.

The reasons for the negative growth effect of both measures of reserves, land and non-timber forest resources, cannot be captured by our set of possible transmission channels. This finding confirms our hypothesis that land and non-timber forest resources are not part of the resource curse hypothesis but rather proxy other geographical factors being detrimental to growth.

With regard to the aggregate export-based proxies for natural resource abundance, we find terms of trade volatility and secondary education to be transmission channels for primary exports (GDP). Terms of trade volatility and secondary education, however, cannot explain the negative growth effect of primary exports (ME) indicating that these transmission channels only play a role when a country's economy considerably relies on primary exports. Among agricultural resources, we detect transmission channels for vegetables and fruit and oilseeds but none for coffee.

The negative growth effects of oilseeds (GDP, ME) can be accounted for by secondary education and in the case of oilseeds (ME) also by growth volatility. Controlling for secondary education, oilseeds (ME) do even positively influence growth.[25]

The negative impact of vegetables and fruit (ME) on growth can be partly explained by bad institutions. This finding supports the "institutions" hypothesis explained above.

[25] These results on oilseeds, however, have to be interpreted with great caution because the curse of oilseeds does not prove to be very robust as shown above.

In the case of mineral resources, we identify transmission channels for fuels and non-ferrous metals.[26] For the curse of fuels (ME), we find terms of trade volatility, economic freedom, inflation, and openness to be relevant transmission channels. The negative growth effect of non-ferrous metals (ME) seems to function via institutions.

Taken together, the results for the transmission channels of the resource curse support our hypothesis that there are different transmission channels for different types of resources. We show that macroeconomic vulnerability partly accounts for the curse of primary exports at the aggregate level and oilseeds and fuels in particular. Institutional quality can partially explain the growth effects of vegetables and fruit, fuels and non-ferrous metals. Economic policy is a relevant transmission channel in the case of primary exports, and oilseeds, fuels and non-ferrous metals at the disaggregated level.

[26] We also find transmission channels for minerals, metals, and fuels. However, we restrict our finding to the case of fuel only because correlation of both variables is very high (0.8). Two other facts support this decision. First, the identified transmission channels are exactly the same ones. And second, the negative growth effects of none of the other proxies for mineral resource abundance can be explained by our set of transmission channels.

Table 3: The transmission channels of the resource curse

		Macroeconomic vulnerability				Institutional quality						Economic policy									
	TC_i	Terms of trade volatility		Growth volatility		Institutions		Economic freedom		Property rights		Inflation		Average tariff rates		Sachs and Warner openness index		Public investment		Secondary education	
NR_i		β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*	β_{NR}	*t-value*
Land (ln)		*-0.21*	*-1.81*	-0.23	-2.30	-0.24	-2.41	*-0.14*	*-1.31*	*-0.16*	*-1.66*	-	-	-	-	*-0.18*	-1.93	*-0.28*	*-2.79*	*-0.15*	*-1.45*
Non-timber forest resources (ln)		-0.19	-1.73	-0.18	-1.72	-0.21	-1.93	-	-	-		-	-	*-0.21*	*-1.87*	*-0.17*	*-1.68*	*-0.23*	*-2.51*	*-0.19*	*-1.79*
Primary exports WDI (GDP)		*-1.58**	*-1.18*	*-1.76*	*-1.59*	-3.58	-2.93	*-1.72*	*-1.53*	-2.18	-2.03	-2.32	-2.24	-	-	*-2.32*	*-1.82*	-2.37	*-1.87*	*-1.68**	*-1.22*
Primary exports WDI (GDP, ln)		*-0.27*	*-1.49*	*-0.27*	*-1.75*	*-0.40*	-2.43	*-0.30*	-2.10	-0.33	-2.41	-0.29	-1.93	-	-	*-0.35*	-2.22	-0.30	*-1.66*	*-0.21*	*-1.36*
Primary exports WDI (ME)		*-2.56*	*-3.04*	*-2.23*	*-3.14*	*-2.40*	*-3.44*	*-1.98*	*-2.84*	*-2.06*	*-3.05*	-2.37	-3.67	*-2.12*	*-2.70*	*-2.52*	*-3.67*	-2.61	*-3.64*	*-1.98*	*-2.96*
Primary exports WDI (ME, ln)		*-0.89*	*-2.82*	*-0.74*	*-2.80*	*-0.73*	*-2.74*	*-0.65*	*-2.48*	*-0.68*	*-2.70*	-0.74	*-2.85*	*-0.64*	*-2.07*	*-0.80*	*-2.96*	-0.85	*-2.64*	*-0.60*	*-2.36*
Primary exports Comtrade (ME)		*-2.40*	*-2.65*	*-2.07*	*-2.85*	*-2.45*	*-3.27*	*-1.66*	*-2.26*	*-1.76*	*-2.46*	*-2.03*	*-2.85*	*-2.08*	*-2.44*	*-2.58*	*-3.39*	-2.92	-4.00	*-1.75*	*-2.38*
Primary exports Comtrade (ME, ln)		*-1.02*	*-2.47*	*-0.93*	*-2.66*	*-1.00*	*-2.81*	*-0.74*	*-2.17*	*-0.79*	*-2.39*	*-0.87*	*-2.48*	*-0.88*	*-2.16*	*-1.11*	*-3.15*	-1.22	-3.26	*-0.66*	*-1.94*
Vegetables and fruit (ME)		-4.73	-2.51	-4.44	-2.24	*-2.33**	*-1.11*	-4.18	-2.12	*-3.78*	*-1.85*	*-3.96*	*-2.06*	-5.19	*-2.49*	-5.39	-2.18	-3.11	-1.61	*-3.74*	*-1.72*
Oilseeds (GDP)		-38.32	-2.80	*-28.64*	*-2.22*	*-28.74*	*-2.01*	-	-	-	-	*-22.37*	*-1.79*	-49.53	*-2.83*	-53.14	*-2.57*	*-30.60*	*-2.16*	*-15.56***	*-0.94*
Oilseeds (ME)		*-1.51*	*-1.85*	*-0.91**	*-1.11*	*-1.43*	*-1.78*	-	-	-	-	*-1.17*	*-1.40*	-2.19	*-2.19*	-3.09	-4.65	*-1.48*	*-1.45*	*0.18****	*0.23*
Coffee (GDP, ln)		-0.14	-3.06	-0.09	-2.03	*-0.11*	-2.43	-0.11	-3.15	*-0.06*	-1.80	-	-	-0.17	-3.66	-0.14	-3.59	-0.11	-2.24	*-0.07*	*-1.51*
Coffee (ME, ln)		-0.16	-3.32	-0.10	-2.07	*-0.11*	*-2.26*	-0.09	-2.36	*-0.07*	-1.64	-0.07	-1.54	-0.18	-3.71	-0.14	-3.60	-0.12	-2.32	*-0.08*	*-1.57*
Ores and metals (GDP)		-8.38	-1.80	-6.96	-2.09	-7.93	-2.15	-6.97	*-1.75*	*-6.05*	*-1.62*	*-6.34*	*-2.15*	-7.42	-1.72	-	-	-5.83	-1.52	*-5.96*	*-1.37*
Ores and metals (GDP, ln)		-0.19	-2.24	*-0.17*	*-2.16*	-0.16	-1.99	-0.15	-1.90	-0.15	-1.87	*-0.13*	*-1.80*	*-0.18*	*-2.10*	-0.16	-2.21	-0.17	*-1.98*	*-0.15*	*-1.84*
Ores and metals (ME)		-2.72	-2.02	-2.57	-2.22	-1.98	*-1.59*	-2.46	-2.03	*-2.32*	*-1.84*	*-2.60*	*-2.52*	-2.16	-1.72	-1.79	-1.73	-2.23	-1.79	*-2.63*	*-2.36*
Ores and metals (ME, ln)		-0.23	-2.38	*-0.20*	*-2.16*	-0.17	-1.82	*-0.16*	*-1.74*	*-0.16*	*-1.70*	*-0.17*	*-1.95*	*-0.25*	*-2.49*	-0.19	-2.26	-0.21	*-2.15*	*-0.20*	*-2.12*
Fuels (ME)		*-0.43****	*-0.58*	*-0.75*	*-1.55*	*-0.74*	*-1.69*	*-0.53****	*-0.84*	*-0.75*	*-1.51*	-0.92	-1.95	-	-	*-0.56**	*-1.16*	-1.15	*-2.34*	-	-
Minerals, metals and fuels (ME)		*-0.62****	*-0.81*	*-0.95*	*-1.66*	*-0.87*	*-1.57*	*-0.64***	*-0.95*	*-0.81*	*-1.40*	*-0.89*	*-1.58*	-	-	*-0.56***	*-1.04*	*-1.38*	*-2.65*	-	-
Non-processed minerals and metals (ME)		-2.00	-1.70	*-2.12*	-2.09	-1.80	-1.55	*-1.92*	*-1.78*	*-1.79*	*-1.65*	*-1.87*	*-1.90*	-2.13	-1.76	-	-	-1.75	*-1.51*	*-1.57*	*-1.41*
Crude minerals (GDP)		-24.42	-3.35	*-21.46*	*-3.18*	*-23.17*	-3.94	-26.53	-2.60	-33.25	-4.74	-27.22	-4.41	*-23.87*	*-3.48*	*-21.95*	*-2.00*	*-20.00*	*-2.85*	-30.87	-3.75
Crude minerals (ME)		-4.89	-2.91	*-4.24*	-2.86	*-4.04*	-3.12	-5.67	-2.10	-6.87	-3.02	-5.03	-3.43	*-4.46*	*-2.91*	*-3.72*	*-1.70*	*-3.44*	-2.23	-5.98	-3.15
Non-ferrous metals (GDP)		-10.12	-2.28	-9.24	-1.89	-8.44	-1.76	-14.74	-3.61	-10.74	-2.95	-	-	-9.25	*-1.92*	*-7.86*	-2.30	-8.67	-1.83	-10.19	-2.60
Non-ferrous metals (ME)		-3.97	*-2.18*	-3.92	-2.18	*-2.03**	*-1.27*	-4.37	-3.23	-3.99	-2.68	-	-	-2.48	*-1.57*	*-2.15*	-1.85	-3.63	-2.11	-2.93	-2.14

*/**/*** indicate that NR_i is NOT significant at the 20/30/40 percent level after controlling for a possible transmission channel. *Cursive* figures denote that the coefficient of NR_i or its t-value respectively are smaller after the inclusion of a potential transmission channel. *Cursive and underlined* figures identify transmission channels, i.e. that NR_i is no longer significant at the 20 percent level and its coefficient is smaller than before. WDI = World Development Indicators, Comtrade = United Nations Commodity Trade Statistics Database, GDP = export share in GDP, ME = share in merchandise exports, ln = logged value, - = the resource curse no longer exists after controlling for the respective channel.

Source: Authors' calculations.

For many of our measures of natural resource abundance, however, the transmission channel of the resource curse cannot be revealed by our regression analysis.[27] In addition, the enormous diversity of countries possibly prevents us from identifying resource-type-specific transmission channels in our simple cross-country regression framework. In particular, as explained above, natural resource abundance has turned out to be a blessing for some countries. The resource curse thus only develops under certain conditions.

Do Country Characteristics Play a Role?

To examine to what extent country characteristics determine the growth impact of different natural resources, we introduce an interaction term in our basic equation:

$$g_i = \alpha + \beta_{gdp} gdp_{1980,i} + \beta_{inv} inv_i + \beta_{NR} NR_i + \beta_C C_i + \beta_{IA}(NR_i \times C_i) + \varepsilon_i \quad (3)$$

where C_i describes country characteristics. By using the interaction term, we can analyse whether the marginal effect of NR_i on growth depends on C_i.[28] For the purpose of our analysis, a country is characterised by its institutional quality and its economic policy. We make use of the same variables as in the preceding section. Likewise, we include only one proxy for C_i in each regression. Our hypothesis is that good institutional quality and good economic policy can offset the resource curse. Hence, we expect the interaction term to have a positive sign. If the absolute value of β_{IA} is larger than the absolute value of β_{NR}, good institutional quality and good economic policy can even turn over the resource curse and make a country profit from its natural resource abundance.[29] We can calculate the threshold for C_i which would exactly compensate the negative impact of natural resources on growth:

$$\frac{\partial g_i}{\partial NR_i} = \beta_{NR} + \beta_{IA} C_i = 0 \quad (4)^{30}$$

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[27] Again, this could be partially explicable by the level of disaggregation. At a certain level of disaggregation, one could not expect a specific resource to have reasonable impact on a country's macroeconomic volatility, institutional quality or economic policy.

[28] Theoretically, we could also interpret the interaction term the other way round meaning that the marginal effect of C_i on growth would depend on NR_i. Practically, however, it does not make much sense that e.g. the marginal effect of institutional quality is worse in a resource-abundant country than in a resource-scarce country.

[29] We can directly compare the coefficients because both NR_i and C_i have been rescaled to a scale from zero to one.

[30] Compare the methodology applied in Mehlum, Moene, and Torvik (2002).

In addition, we also estimate another specification which includes a quadratic interaction term to detect a possibly non-linear relationship between NR_i and C_i:

$$g_i = \alpha + \beta_{gdp} gdp_{1980,i} + \beta_{inv} inv_i + \beta_{NR} NR_i + \beta_{NR^2} NR_i^2 + \beta_C C_i + \beta_{IA}(NR_i \times C_i) + \beta_{IA^2}(NR_i^2 \times C_i) + \varepsilon_i \quad (5)$$

For this specification, the threshold can only be calculated as a function of NR_i. Therefore, we only present thresholds for the case described above.

Our results are summarised in Tables 4 and 5. The adjusted R^2s (between 0.38 and 0.61) indicate that through the inclusion of the interaction term our new specification can explain somewhat more of the variation in the growth rates. As can be seen very clearly, the impact of virtually all natural resources on growth depends on country characteristics. Yet, different characteristics appear to be important for different resource types.

Table 4: Country characteristics and the resource curse

		Institutional quality			**Economic policy**				
NR_i	C_i	Institu-tions	Eco-nomic freedom	Property rights	Inflation	Average tariff rates	Sachs and Warner openness index	Public invest-ment	Secon-dary education
Land (ln)		■**			-	-			
Non-timber forest resources (ln)		■*	-	-	-				
Primary exports WDI (GDP)			◆*			-	◆***	◆*	
Primary exports WDI (GDP, ln)		■*	■*◆*			-	■**◆**	■*	
Primary exports WDI (ME)		◆*							◆**
Primary exports WDI (ME, ln)		■*				■**	■**		
Primary exports Comtrade (ME)									
Primary exports Comtrade (ME, ln)									
Vegetables and fruit (ME)							◆**		
Oilseeds (GDP)			-	-	◆**		■*		■***
Oilseeds (ME)			-	-		■*			■*
Coffee (GDP, ln)		◆**			-			◆**	◆**
Coffee (ME, ln)		◆*			■**		◆*		◆*
Ores and metals (GDP)			◆***	◆***	◆*	■***	-		
Ores and metals (GDP, ln)		◆*	◆**	◆*		■*			
Ores and metals (ME)						■***	◆**		
Ores and metals (ME, ln)						◆*			
Fuels (ME)					■*	-		◆***	-
Minerals, metals and fuels (ME)		◆**			■***	-	◆**	◆*	-
Non-processed minerals and metals (ME)						◆***	-		
Crude minerals (GDP)			■**		◆**	◆**	■***	■*	■***
Crude minerals (ME)					◆**		■***	◆*	■***
Non-ferrous metals (GDP)		◆***		■***	-		■*	◆***	◆**
Non-ferrous metals (ME)		◆***	■**	■***	-	◆***			

■ linear interaction term ($NR_i \times C_i$) is significant (see equation (3)), ◆ quadratic interaction term ($NR_i^2 \times C_i$) is significant (see equation (5)). */**/*** indicate that the respective interaction term is significant at the 10/5/1 percent level. WDI = World Development Indicators, GDP = export share in GDP, ME = share in merchandise exports, ln = logged value, - = the resource curse no longer exists in the adjusted sample.
Source: Authors' calculations.

Institutional quality, measured by institutions, economic freedom, and property rights, seems to be a decisive element of the growth impact of many resource types but above all of point-source resources. The growth effects of both measures of reserves, land and non-timber forest resources, depend on institutional quality. So do the growth effects of primary exports WDI (GDP, ME) at the aggregate level, and of coffee (GDP, ME), ores and metals (GDP), minerals, metals and fuels (ME), crude minerals (GDP), and non-ferrous metals (GDP, ME) at the disaggregate level.

The thresholds indicate that institutional quality has to be perfect to reverse the resource curse.[31] In a few cases, the thresholds are larger than one meaning that even first-class institutions can only mitigate but not compensate the resource curse. An exception is the moderate threshold for economic freedom in the case of crude minerals.

At the disaggregated level, economic freedom only determines the growth effect of mineral resources but not of agricultural resources. As rents from mineral resources, in contrast to agricultural resources, are largely earned by governments, the possibility rises that these rents are used to intervene in economic activities. Our finding suggests that when a government has access to rents from point-source resources, it is vital for growth that economic freedom is being granted. This would also explain the comparatively low threshold in the case of crude minerals since rents from crude minerals which include fertilizer, sand, natural abrasives, and sulphur are far less likely to be earned by governments.

Property rights only play a decisive role when natural resources are easily appropriable. Ores and metals and in particular non-ferrous metals such as silver, nickel, and copper are the resource types whose growth impact depends on the quality of property rights.

There are some resources, however, whose growth effect is not affected by institutional quality: vegetables and fruit, oilseeds, coffee, fuels, and non-processed minerals and metals. These resources are a curse regardless of the institutional quality. In the case of vegetables and fruit and fuels this might partly be explicable by our previous finding that institutional quality is a transmission channel for these two resource types. Through their detrimental effect on institutional quality, they hinder countries abundant in the respective resources from developing institutions with which they could manage their resource wealth.

[31] Mehlum, Moene, and Torvik (2002) present a similar finding.

Table 5: Thresholds for country characteristics

		Institutional quality			Economic policy				
NR_i	C_i	Institu-tions	Eco-nomic freedom	Property rights	Inflation	Average tariff rates	Sachs and Warner openness index	Public invest-ment	Secon-dary education
Land (ln)		1.00							
Non-timber forest resources (ln)		1.02							
Primary exports WDI (GDP)									
Primary exports WDI (GDP, ln)		1.01	0.80				0.96	0.05	
Primary exports WDI (ME)									
Primary exports WDI (ME, ln)		1.09				-0.05	1.22		
Primary exports Comtrade (ME)									
Primary exports Comtrade (ME, ln)									
Vegetables and fruit (ME)									
Oilseeds (GDP)							0.43		0.28
Oilseeds (ME)						0.45			0.21
Coffee (GDP, ln)									
Coffee (ME, ln)					0.25				
Ores and metals (GDP)						0.26			
Ores and metals (GDP, ln)						0.11			
Ores and metals (ME)						0.20			
Ores and metals (ME, ln)									
Fuels (ME)					0.01				-
Minerals, metals and fuels (ME)					0.02				-
Non-processed minerals and metals (ME)									
Crude minerals (GDP)			0.47				-0.15	0.06	0.34
Crude minerals (ME)							-0.06		0.40
Non-ferrous metals (GDP)				0.76			0.54		
Non-ferrous metals (ME)			0.78	0.78					

Threshold should have values between 0 and 1. In a few cases, however, they are slightly smaller than 0 or slightly larger than 1. Then, they can be interpreted in the same way but it is no longer possible to reverse the resource curse. WDI = World Development Indicators, GDP = export share in GDP, ME = share in merchandise exports, ln = logged value, - = the resource curse no longer exists in the adjusted sample.

Source: Authors' calculations.

Economic policy, proxied by inflation, average tariff rates, the Sachs and Warner openness index, public investment, and secondary education, appears to be even more decisive than institutional quality in determining the growth effect of most resource types.

The growth impact of primary exports WDI (GDP, ME) at the aggregate level and of all agricultural and mineral resources at the disaggregate level depends on economic policy. Economic policy, however, does not influence the growth effects of both reserves, land and non-timber resources. Thus, the production of natural resources is rather a blessing than a curse as long as no policy mistakes are made. This is particularly true for point-source resources.

Regarding the different proxies for economic policy, the following can be said. The importance of low inflation policies seems to rise for point-source resources

whose rents are typically earned by governments. In the case of fuels (ME) and minerals, metals and fuel (ME) the inflation thresholds are extremely low whereas for coffee (ME) the threshold is rather moderate.

Openness, measured by average tariff rates and the Sachs and Warner openness index, is the most remarkable determinant of a resource's impact on growth. The thresholds, however, reveal somehow inconsistent results. At the aggregate level the thresholds suggest that complete openness could reverse the resource curse. At the disaggregate level, the thresholds indicate that a moderate degree of openness is enough to offset the resource curse. In the case of oilseeds and crude minerals, the sign of the interaction term (not reported) even implies that completely closed economies can best profit from their resource abundance.[32]

Public investment is a critical factor in determining the growth effect of particularly mineral resources. The quite low thresholds and the sign of the interaction term suggests that countries where governments use resource rents for excessive public investment experience low growth whereas this is not the case in resource-rich countries with low rates of public investment.

Secondary education is of particular significance for the impact of oilseeds, coffee, and crude minerals. Remarkably these resource types typically offer very good opportunities for developing forward and backward linkages which normally require better-skilled workers. Therefore, education might be critical factor as countries with higher education levels have a greater capacity to add a greater share of final product value. As the thresholds show, moderate secondary education levels are enough to offset the resource curse in these cases.

Although this estimation framework does not allow us to find direct evidence for transmission channels, it provides interesting insights into the socio-economic environment in which the resource curse develops. Nevertheless, we want to stress that the explanatory power of the analysis of the interaction terms is limited. The calculated thresholds only draw a line between those countries which have profited from their wealth in natural resources and others which have failed in doing so. Thus, we only present similarities between these two groups of countries. Yet, this does not imply that once a country reaches a threshold it will automatically benefit from its natural resources. In addition, our analysis is not complete as we have only considered one country characteristic in each regression. It may well be that a country is above the threshold in e.g. institutional quality but below it in economic policy. In such a case, our estimation framework is not able to give a satisfactory explanation of the overall effect on growth.

[32] This finding for oilseeds and crude minerals is puzzling, as it is neither consistent with our expectations and not with previous research on openness. Such a result however points to the usual caution that should be exercised when interpreting cross-country regression results. Remember that the curse for oilseeds did not prove to be robust.

Nevertheless, the examination of the role of country characteristics allows us to draw two important conclusions. First, different country characteristics are critical in determining the effects of different types of natural resources on growth. Country characteristics are of particular importance for the impact of point-source resources. On the whole, factors of economic policy seem to be more decisive than factors of institutional quality. Second, country characteristics differ a lot between countries and are of an extraordinary significance for the growth effect of natural resources. Therefore, case studies focusing on single countries or regions could be a promising alternative to cross-country regressions in understanding the transmission channels of the resource curse.

Conclusions

The review and the synthesis of the existing theories of the transmission channels of the resource curse have suggested that a distinction between different types of resources could contribute to a better understanding of the functioning of the resource curse. In particular, we can think of five aspects, in which resource types can differ, and therefore might have a different impact on growth: (1) production technologies, (2) the degree of rent dispersion, (3) the potential of forward and backward linkages, (4) the feasibility of rent appropriation through state institutions, (5) and long-term trends in commodity prices and price volatility. This theoretical analysis has raised three important questions: What is the growth impact of different types of resources? Are different transmission channels related to different types of resources? In addition, the theoretical as well as the empirical cross-country literature has been relatively silent on natural resources being a curse for some and a blessing for other countries. Therefore, we have addressed the question which role country characteristics play in determining whether a resource type is detrimental or beneficial to growth. Our empirical results can be summarised as follows. First, the growth impact of natural resources depends on the resource type. Some resource types have positive, others negative effects on growth. And, quite a few resources are not a significant determinant of growth. Second, there is evidence that the curse of different types of resources functions via different transmission channels. Depending on the natural resource type, macroeconomic volatility, institutional quality, economic policy, or a combination of these aspects are found to be relevant transmission channels. Third, country characteristics are important in determining a resource's influence on growth. Our results show that high institutional quality but, above all, sound economic policies can overcome the curse. Again, different country characteristics matter for different types of resources. Thus, the interplay of the resource type and a country's characteristics decides whether a natural resource turns out to be a curse or a blessing.

The results of our paper and the identified theoretical and empirical gaps and problems point towards possible areas of future research on the resource curse.

In particular with regard to the transmission channels much work has to be done to better understand how natural resources affect growth. A case in point is the short term commodity price volatility as well as the alleged secular decline of developing countries' terms of trade. A lot of effort has been dedicated to study commodity price time series to understand price behaviour. This is of course a worthwhile exercise, but we think that too little research has been done on the link between commodity price behaviour and economic performance. Not only in this context, the analysis of the transmission channels of the curse should consider different types of resources.

Although we have stressed the role of dynamics and expectations in understanding the curse, the applied empirical approach ignores this dimension. Yet, in light of methodological and data problems it remains to be seen whether panel models can offer more insights into the dynamics of the resource curse.

As our results indicate, country characteristics determine to quite some extent whether a natural resource has a positive or negative effect on growth. In addition, the theory suggests that the transmission channels of the resource curse are interdependent. If this is indeed the case, the insights from cross-country studies with regard to the transmission channels will not go much beyond of what we have shown. Then, future research should focus on detailed comparative country studies.

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Appendix

Sample

To ensure that our sample is not dominated by too many small countries, only countries with more than one million inhabitants in 2000 have been considered for the sample. Out of the 152 remaining countries, data are available for the following 119 countries:

Algeria	Cote d'Ivoire	Indonesia	Namibia	Slovak Republic
Angola	Cuba	Iran, Islamic Rep.	Nepal	South Africa
Argentina	Denmark	Ireland	Netherlands	Spain
Australia	Dominican Republic	Israel	New Zealand	Sri Lanka
Austria	Ecuador	Italy	Nicaragua	Sudan
Bangladesh	Egypt, Arab Rep.	Jamaica	Niger	Swaziland
Belgium	El Salvador	Japan	Nigeria	Sweden
Benin	Ethiopia	Jordan	Norway	Switzerland
Bolivia	Finland	Kenya	Oman	Syrian Arab Republic
Botswana	France	Korea, Rep.	Pakistan	Tajikistan
Brazil	Gabon	Kuwait	Panama	Tanzania
Bulgaria	Gambia	Lao PDR	Papua New Guinea	Thailand
Burkina Faso	Georgia	Latvia	Paraguay	Togo
Burundi	Germany	Lesotho	Peru	Trinidad and Tobago
Cameroon	Ghana	Madagascar	Philippines	Tunisia
Canada	Greece	Malawi	Poland	Turkey
Central African Republic	Guatemala	Malaysia	Portugal	Uganda
Chad	Guinea	Mali	Puerto Rico	United Kingdom
Chile	Guinea-Bissau	Mauritania	Romania	United States
China	Haiti	Mauritius	Rwanda	Uruguay
Colombia	Honduras	Mexico	Saudi Arabia	Venezuela, RB
Congo, Dem. Rep.	Hong Kong, China	Mongolia	Senegal	Zambia
Congo, Rep.	Hungary	Morocco	Sierra Leone	Zimbabwe
Costa Rica	India	Mozambique	Singapore	

Data description

To keep the sample size as large as possible and to include a maximum number of developing countries, some exceptions (in the year or data source) have been made which are all documented in the subsequent data description.

g_i	Geometric mean of the annual growth rates in country i in the years 1980-2000; source: World Bank (2003). World Development Indicators.
$gdp_{1980,\,I}$	Logged GDP per worker in country i in 1980; source: World Bank (2003). World Development Indicators. Exceptions: Angola (1980, Penn World Table, http://pwt.econ.upenn.edu), Cuba (1985, Penn World Table), Ethiopia (1981), Guinea (1981, Penn World Table), Lao PDR (1984), Mongolia (1981), Namibia (1980, Penn World Table), Poland (1980, Penn World Table), Romania (1980, Penn World Table), Slovak Republic (1984), Tajikistan (1985), Tanzania (1980, Penn World Table), Uganda (1980, Penn World Table).
inv_i	Average annual investment rates in country i between 1980 and 2000; source: Penn World Table. http://pwt.econ.upenn.edu
NR_i	
Land	Land per capita (in hectares), averaged over the period 1980-2000; source: World Bank (2003). World Development Indicators. Source of population: World Bank (2003). World Development Indicators.
Arable land	Arable land per capita (in hectares), averaged over the period 1980-2000; source: World Bank (2003). World Development Indicators.
Natural capital	Natural capital per capita in 1994 (in US$); source: World Bank (1997). Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development.
Pastureland	Pasture land per capita in 1994 (in US$)
Cropland	Cropland per capita in 1994 (in US$)
Timber resources	Timber resources per capita in 1994 (in US$)
Non-timber forest resources	Non-timber forest resources per capita in 1994 (in US$)
Subsoil assets	Subsoil assets per capita in 1994 (in US$)
Reserves of oil 1982	Proved per capita reserves of oil in 1982 (in thousand million barrels); source: British Petroleum (2003). Statistical Review of World Energy 2003.
Reserves of natural gas 1982	Proved per capita reserves of natural gas in 1982 (in trillion cubic metres); source: British Petroleum (2003). Statistical Review of World Energy 2003.
Primary exports (WDI)	Share of resource-based exports in GDP or ME respectively, mean of the averages of the 1980s and 1990s, comprise the SITC sections 0, 1, 2, 3, 4, and 68; source: World Bank (2003). World Development Indicators.
Food	Comprises the commodities in SITC sections 0 (food and live animals), 1 (beverages and tobacco), and 4 (animal and vegetable oils and fats) and SITC section 22 (oil seeds, oil nuts, and oil kernels).
Agricultural raw materials	Comprise SITC section 2 (crude materials except fuels) excluding divisions 22, 27 (crude fertilizers and minerals excluding coal, petroleum, and precious stones), and 28 (metalliferous ores and scrap).
Fuels	Comprise SITC section 3 (mineral fuels).
Ores and metals	Comprise the commodities in SITC divisions 27, 28, and 68 (nonferrous metals).

Primary exports (Comtrade)	Share of resource-based exports in GDP or ME respectively, mean of the averages of the 1980s and 1990s, comprise the SITC sections 0 (food and animal), 1 (beverages and tobacco), 2 (crude materials, inedible, except fuels), and 4 (animal and vegetable oils and fats) and the commodities in SITC divisions 32 (coal, coke and briquettes), 33 (petroleum and petroleum products), 34 (gas, natural and manufactured), 66 (non-metallic mineral manufactures: lime, cement, and fabricated construction materials, clay construction materials, mineral manufactures, glass, glassware, pottery, pearls and precious stones), 67 (iron and steel: pig-iron, spiegeleisen, sponge iron, iron or steel granules and powders and ferro-alloys, ingots, flat-rolled products of iron, non-alloy steel and alloy steel, iron and steel bars, rods, angles, shapes and sections, rails or railway track construction material, wire of iron or steel, tubes, pipes and hollow profiles), 68 (non-ferrous metals: silver, platinum, copper, nickel, aluminium, lead, zinc, tin, miscellaneous non-ferrous base metals employed in metallurgy, and cermets), and 69 (manufactures of metal: structures of iron, steel or aluminium, metal containers, wire products, nails, screws, nuts, bolts and rivets of iron, steel, copper or aluminium, tools for use in the hand or in machines, cutlery, manufactures of base metals); source: United Nations. Commodity Trade Statistics Database. Exceptions: Belgium (1980s: 1993), Benin (1980s: 1974, 1992), Botswana (1980s: 2000), Bulgaria (1980s: 1996), Burkina Faso (1980s: 1975, 1995), Burundi (1980s: 1976, 1993), Congo, Dem. Rep. (1980s: 1979, 1990s: 1979), Cote d'Ivoire (1980s: 1975, 1995), Cuba (1990s: 2001), Egypt, Arab Rep. (1980s: 1980, 1994), Ethiopia (1980s: 1993), Gabon (1980s: 1975, 1997), Gambia (1980s: 1995), Georgia (1980s: 1999), Ghana (1980s: 1992), Guinea (1980s: 1995), Guinea-Bissau (1980s: 1975, 1990s: 1975), Hong Kong (1980s: 1992), Hungary (1980s: 1992), Indonesia (1980s: 1978, 1989), Iran (1980s: 1977, 1997), Jamaica (1980s: 1991), Korea, Rep. (1980s: 1994), Lao PDR (1980s: 1974, 1990s: 1974), Latvia (1980s: 1994), Lesotho (1990s: 2001), Madagascar (1980s: 1975, 1990), Mali (1980s: 1976, 1996), Mauritania (1980s: 1972, 1990s: 1972), Mongolia (1980s: 1996), Morocco (1980s: 1975, 1993), Namibia (1980s: 2000), Niger (1980s: 1975, 1995), Papua New Guinea (1980s: 1998), Peru (1980s: 1975, 1992), Philippines (1980s: 1972, 1991), Poland (1980s: 1992), Rwanda (1980s: 1996), Saudi Arabia (1980s: 1975, 1991), Senegal (1980s: 1975, 1996), Slovak Republic (1980s: 1994), South Africa (1980s: 2000), Sudan (1980s: 1994), Swaziland (1980s: 2000), Syrian Arab Republic (1980s: 1976), Trinidad and Tobago (1980s: 1978, 1991), Tunisia (1980s: 1979, 1990), Uganda (1980s: 1994), Zambia (1980s: 1993). Source of GDP: World Bank (2003). World Development Indicators.
Agricultural products	Comprise the SITC sections 0, 1, and 4 and the commodities in SITC divisions 21 (hides, skins and fur skins, undressed), 22 (oilseeds, oil nuts and oil kernels), 23 (crude rubber including synthetic and reclaimed), 26 (textile fibres, not manufactured, and waste), and 29 (crude animal and vegetable materials).
Non-processed agricultural products	Comprise the commodities in SITC divisions 00 (live animals), 04 (cereals and cereal preparations), 05 (fruit and vegetables), and 29.
Live animals	Comprise the commodities in SITC division 00.
Cereals	Comprise the commodities in SITC division 04.
Vegetables and fruit	Comprise the commodities in SITC division 05.
Crude animal and vegetable materials	Comprise the commodities in SITC division 29.
Processed agricultural products	Comprise SITC section 4 and the commodities in SITC divisions 01 (meat and meat preparations), 02 (dairy products and eggs), 03 (fish and fish preparations), 08 (feeding stuff for animals excluding unmilled cereals), 09 (miscellaneous food preparations), 11 (beverages), and 21.
Animal products	Comprise the commodities in SITC divisions 01, 02, 03, and 21.
Meat	Comprises the commodities in SITC division 01.
Dairy products and eggs	Comprise the commodities in SITC division 02.
Fish	Comprises the commodities in SITC division 03.

Hides and skins	Comprise the commodities in SITC division 21.
Beverages	Comprise the commodities in SITC division 11.
Animal and vegetable oil and fats	Comprise SITC section 4.
Other processed agricultural products	Comprise the commodities in SITC divisions 08 and 09.
Cash crops	Comprise the commodities in SITC divisions 06 (sugar, sugar preparations and honey), 07 (coffee, tea, cocoa, spices and manufactures thereof), 12 (tobacco and tobacco manufactures), 22, 23, and 26.
Sugar	Comprises the commodities in SITC division 06.
Coffee	Comprises the commodities in SITC division 071 (coffee).
Cocoa and chocolate	Comprise the commodities in SITC divisions 072 (cocoa) and 073 (chocolate and other food preparations containing cocoa).
Tea	Comprises the commodities in SITC division 074 (tea and mate).
Spices	Comprise the commodities in SITC division 075 (spices).
Tobacco	Comprises the commodities in SITC division 12.
Oilseeds	Comprise the commodities in SITC division 22.
Rubber	Comprises the commodities in SITC division 23.
Textile fibres	Comprise the commodities in SITC division 26.
Wood and paper	Comprise the commodities in SITC divisions 24 (wood, lumber and cork) and 25 (pulp and paper).
Minerals, metals and fuels	Comprise the commodities in SITC divisions 27 (crude fertilizers and crude minerals: crude fertilizers, stone, sand and gravel, sulphur, natural abrasives, other crude minerals), 28 (metalliferous ores and metal scrap: iron ores and concentrates, ferrous waste and scrap, copper ores and concentrates, nickel ores and concentrates, aluminium ores and concentrates, uranium ores and concentrates, ores and concentrates of base metals, non-ferrous base metal waste and scrap, ores and concentrates of precious metals), 32, 33, 34, 66, 67, 68, and 69
Non-processed minerals and metals	Comprise the commodities in SITC division 27, 28, 66, 67, 68, and 69.
Crude minerals	Comprise the commodities in SITC division 27.
Metalliferous ores	Comprise the commodities in SITC division 28.
Non-ferrous metals	Comprise the commodities in SITC division 68.
Iron and steel	Comprise the commodities in SITC division 67.
Processed minerals and metals	Comprise the commodities in SITC divisions 66 and 69.
Mineral fuels	Comprise the commodities in SITC divisions 32, 33, and 34.
Coal	Comprises the commodities in SITC division 32.
Petroleum	Comprises the commodities in SITC division 33.
Gas	Comprises the commodities in SITC division 34.
TC_i and C_i	
Terms of trade volatility	Variance of net barter terms of trade in the period 1980-2000; source: World Bank (2003). World Development Indicators.
Growth volatility	Variance of annual growth rates in the period 1980-2000; source; World Bank (2003). World Development Indicators.

Institutions	Value of 1982. We opted for this year as institutions are highly endogenous and there are no meaningful instruments. Institutions is an unweighted average of the five subindices rule of law, bureaucratic quality, corruption in government, risk of expropriation, and government repudiation of contracts. We do not consider these subindices as the correlation with institutions is very high (always > 0.8404) which would not permit a sharp distinction between the different elements of institutional quality; source: Sachs, J.D. and A.M. Warner (1997). Sources of Slow Growth in African Economies. Journal of African Economies, Vol. 6, 3, pp. 335-376. http://www2.cid.harvard.edu/Warner's%20Files/africa.xls
Economic freedom	Value of 1997. Economic freedom is defined as the absence of government coercion or constraint on the production, distribution, or consumption of goods and services beyond the extent necessary for citizens to protect and maintain liberty itself, i.e. people are free to work, produce, consume, and invest in the ways they feel are most productive. The following factors are considered: trade policy, fiscal burden of government, government intervention in the economy, monetary policy, capital flows and foreign investment, banking and finance, wages and prices, property rights, regulation, informal market; source: Index of Economic Freedom. http://www.heritage.org/research/features/index/pastScores.xls
Property rights	Value of 1997; source: Index of Economic Freedom. http://www.heritage.org/research/features/index/pastScores.xls
Inflation	Average annual inflation rate in the period 1980-2000; source: World Bank (2003). World Development Indicators. Seven outliers (with all had annual inflation rates higher than 400 percents) have been identified: Congo, Dem. Rep., Nicaragua, Angola, Bolivia, Peru, Brazil, and Argentina. Three of these countries are typical examples of the resource curse: Nicaragua, Angola, and Bolivia.
Average tariff rates	Average import duties as percent of imports for the 1980s and 1990s; source: Yanikkaya, H. (2003). Trade Openness and Economic Growth: a Cross-Country Empirical Investigation. Journal of Development Economics, Vol. 72, pp. 57-89.
Sachs and Warner openness index	Average value in the period 1980-2000; source: Sachs, J.D. and A.M. Warner. Trade Openness Indicators. http://www2.cid.harvard.edu/Warner's%20Files/sachswarneropen.xls
Public investment	Average annual public investment rate in the period 1980-2000; source: Easterly, W. and M. Sewadeh. Database for Global Development Network. http://www.worldbank.org/research/growth/pdfiles/GDN/macro_time_series_6_2001.xls
Secondary education	Log of average years of secondary education in the population older than 25 in 1990; source: Barro, R.J. and J.-W. Lee (2000). International Data on Educational Attainment: Updates and Implications. CID Working Paper No. 42. http://www2.cid.harvard.edu/ciddata/barrolee/panel_data.xls