The Irony of Resource Wealth: an Empirical Investigation of the Short-Run Effects of Natural Resource Abundance

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Abstract

This paper provides an empirical analysis of the effects of natural resource wealth on short-run economic growth. In addition, the market mechanisms resulting from natural resources abundance are investigated. The analysis is conducted first on a global scale for the period 1980-2011, and second on the regional scale of the United States for the period 1987-2012. This allows me to exploit the different advantages that come with the two distinct methods. As most of the early work is based on single cross-sectional growth regressions which do not take into account individual country effects, two new panel-datasets are constructed. These are tested using a system GMM approach to counter the potential bias resulting from the dynamic panel-data framework used in this analysis. Strikingly, the results show that the original findings of the resource curse thesis are not robust to changing the econometric framework and sample period. Both on a global and regional scale, the estimated effect of natural resource wealth on short-run economic growth is positive and significant, indicating that the resource curse could actually be a resource blessing. These findings are robust to the three different estimators and the adoption of two alternative measures of resource wealth. Exploratory steps on the reason behind this contradicting finding, indicate that a negative coefficient could be the result of specific decades in which natural resources prices were more volatile. Contrary to the effect on growth, no robust evidence is found for both market channels of resource wealth examined in this study. The possible absence of these channels is in favour of the reported positive effect of resource wealth on economic growth.

Contents

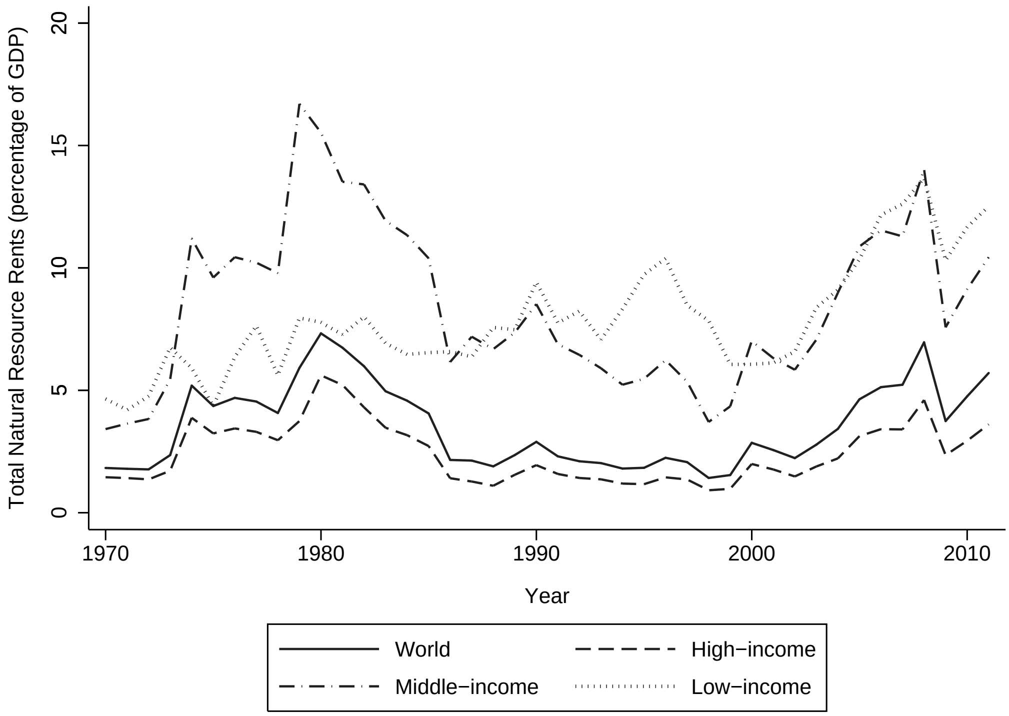
1. Introduction

In the summer of 1959, a giant natural gas field was discovered near the Dutch town of Slochteren in the north-eastern part of the Netherlands. With the discovery of the potentially largest supply of inland gas on the European continent, there was no reason for the Dutch to believe this resource boom could be of any harm to their domestic economy. Unfortunately for them, the new-found deposits of natural wealth resulted in an unforeseen decline in competitiveness of the Dutch economy leading to serious economical struggles in the early 1960s. This striking relationship, often referred to as the *Dutch disease*, is not just limited to the Dutch borders. All over the world, countries blessed with an abundance of natural resources appear to be struggling to translate their natural wealth into economic wealth. One of the most distressing cases can be found in Liberia, a resource-driven economy based in Sub-Saharan Africa. In 1970, the Liberian economy consisted for almost 27 percent of natural resource rents. Over the next 41 years, the Liberian population saw their real per-capita income fall with a staggering 64 percent (World Bank, 2013). A handful of countries however, Norway, the United Kingdom and Canada amongst others, did seem to manage to fully exploit the merits of their natural richness.

Are valuable deposits of natural resources responsible for this economic downturn or is this the result of other factors at play? What er the channels through which these possible adverse effects work, and why are some resource-rich countries performing better than others? Ever since the occurrence of these contradictory experiences, economists have made attempts to unfold the answers to these questions. The value of these efforts lies in the fact that natural resources play a substantial role in the world economy. In 2011, the economic rents originated from natural resource deposits amounted to 4.3 trillion U.S. Dollars, roughly equivalent to 6 percent of the total world income (World Bank, 2013). Figure 1 shows that for low-income countries this share is even higher, 13 percent of total GDP in 2011. These developing countries, desperately seeking a path out of poverty, seem to be hit hardest by the potentially adverse effects of resource wealth. Recent breakthroughs in exploration and production technologies will allow the exploitation of new and more remote resource-abundant locations, previously inaccessible to mankind. For that reason, it is not implausible to belief that resource-based economies will continue to persist in the near future. Moreover, it could well be the case that resource-poor countries will experience periods of resource wealth, when previously unviable deposits will be tapped into. A clear view of the potentially adverse effects of natural wealth, and the different pathways through which these are manifested, could help in the understanding and ways to deal with large endowments of natural resource richness.

The vast amount of research on this subject is often summarized as the *natural resource curse* literature, following the negative effect found in much of the influential work (Frankel, 2010). Efforts aimed

Figure 1: Dependency on Natural Resource Rents



Source: World Development Indicators 2013, World Bank

at understanding the channels of this so-called curse fail to show a one-sided picture. Two leading explanations include deterioration of political and institutional factors through rent-seeking behaviour, corruption, and protectionist policies, on one side. A second explanation is the *Dutch disease* theory, which postulates that adverse market equilibrium effects are caused by de-industrialisation and loss of competitiveness in resource-rich countries. Further research aimed at understanding both channels is warranted. Moreover, several shortcomings clinging to this field of research can be identified. First of all, the typical approach employed in empirical studies in this field rely on cross-country growth regressions based on the work by Barro (1991). This strategy comes with several limitations however, which lie in the implicit assumption that difficult to measure, and therefore omitted, characteristics are uncorrelated with the dependent and explanatory variables. A more realistic view however would be that country-specific structural characteristics do impose a direct effect on the other variables, leading to biased results of a cross-sectional regressions (Islam, 1995). Second, contradicting results in this field of research can be attributed to differences in the choice of countries, sample periods and measures of resource abundance. Issues may further arise due to variation in definitions and measurement methodology of explanatory and control variables, across countries.

To overcome these issues, this paper adopts a dynamic panel-data approach which allows for country-specific fixed effects. For this purpose, a new global dataset is constructed including 163 countries covering the period 1980-2011. Variation in natural resource rents across countries is exploited to examine the potential prevalence of the curse. In an aim to unravel the workings of the curse, the market effects in resource-rich countries are investigated. To this end, the framework by Corden and Neary (1982) is adopted, which postulates that resource wealth has a corroding effect on the manufacturing sector and raises the relative price level of countries, hampering the potential growth path of the economy. Subsequently, the empirical framework is applied to the 50 United States for the timespan 1987-2012, to investigate the resource curse thesis on a regional level. On this level, several confounding factors are minimized, as political and institutional factors are largely determined on a national level for example. Although the U.S. economy is not based on natural resource abundance alone, heterogeneity in resource rents across states provides an interesting case for examining the potential curse. Furthermore U.S. data can be considered relatively accurate due to the high standards of data collection and reporting. To my knowledge, no empirical research has been conducted yet on the market effects of resource wealth in the United States. Finally, utilizing two datasets allows for a comparison of methodology and results, and the exploitation of the different advantages that come with the two approaches.

Contrary to most of the earlier work on the curse, the main results indicate that the original findings are not robust to changes in the econometric framework. Adopting a system GMM approach, evidence is found for a positive relationship between resource wealth and economic growth, indicating that the resource curse could actually be a resource blessing. These results are robust to estimation using three different estimators, inclusion of other covariates, time dummies, and alternative measures of resource wealth. On the contrary no conclusive evidence is found for the potential market mechanisms of resource abundance. The results of the country study on the United States appear to confirm the positive effect on short-run growth. However, no conclusive evidence is found for the potential market mechanisms of resource abundance in the U.S. either. I show that the negative effect found in earlier work could be the result of the chosen sample period, as the last decade especially shows a strong positive effect of resource wealth. Furthermore, the results show that the growth-enhancing channel found in this study seems to be largely driven by oil and gas rents.

The rest of this paper is organized as follows. Section 2 provides an overview of the relevant earlier work on the resource curse. The theoretical foundations underlying the empirical strategy are presented in section 3. Section 4 highlights the empirical framework constructed for examining the resource curse on both scales, while the data is described in section 5. Section 6 presents the results of the empirical tests. In section 7, the resource curse is investigated on the United States level. Section 8 provides a discussion and finally, section 9 concludes.

2. The Resource curse: an overview

A large volume of research aimed at solving the paradox of resource wealth has emerged over the past few decades. At the same time, various pathways through which these effects are manifested have been brought forward. These previous studies can be split into two distinct categories. The first category builds upon the seminal work by Corden and Neary (1982) and is focused on the market equilibrium effects of resource windfalls, also known as *Dutch disease* effects. The second stream of research examines political and institutional factors affected by resource-driven wealth. Due to the vastness of literature on both categories, a selection of relevant and influential work is presented in this section. Studies examining the market effects of resource wealth are summarized in section 2.1, section 2.2 presents the most influential works looking at the political and institutional effects. Section 2.3 highlights the latest stream of studies which adopt a regional dataset, and finally section 2.4 brings forward some of the limitations that arise from the previous research papers in this field.

2.1. Dutch disease: market linkages of resource wealth

The seminal work on the resource curse before the term was coined is Corden and Neary (1982). This study is inspired by the economic struggles faced in the Netherlands in the 1960s. In this work a formal model on the market equilibrium effects of natural resource windfalls is developed. The framework, considering a small open economy, theorizes that a resource windfall subsequently leads to a loss in competitiveness, impairing the economic performance of a country. This decline in a country's comparative position is caused by two effects. On the one hand, a shift of production factors away from the country's manufacturing sector towards the resource sector occurs, caused by the higher factor returns following a resource windfall. This leads to a shrinkage of the manufacturing sector also termed de-industrialization. On the other hand, the extra income from the resource wealth is spent domestically on the non-traded sector, causing the price level of the country to increase relative to other countries. This can be interpreted as the equivalent of an appreciation of the real exchange rate. This further deteriorates the competitiveness of the country. Van Wijnbergen (1984), in his framework shows that precisely this crowding-out of the non-traded manufacturing sector will delay *learning-by-doing* externalities created in the sector. With the important role of learning-by-doing in technological progress, a temporary decline in the manufacturing sector may permanently lower the per capita income of a country. Focusing on agriculture instead of the natural resource sector, Matsuyama (1992) presents similar results for open economies. In addition he shows that the curse can turn into a blessing in the case of closed economies, as an increase in agricultural productivity shifts labour to the manufacturing sector. Sachs and Warner (1995), further building upon the earlier frameworks, introduce an even more advanced endogenous growth model incorporating resource wealth. The main results of this framework imply that countries experiencing a resource windfall go through several periods of lower growth compared to identical economies without the boom. This magnitude of the effect depends on the capital intensities of the three sectors. The original model introduced by Corden and Neary (1982) forms the basis for the empirical analysis in this study and is explained in detail in section 3.1.

The theoretical Dutch disease work of the 1980s and 1990s paved the way for empirical investigation on the resource wealth effects on economy performance. The majority of the early work on these mechanisms consists of country case studies such as Forsyth (1986) on the experiences of resource windfalls in Australia and the United Kingdom, and Benjamin et al. (1989) for oil-rich Cameroon. The main disadvantage of these studies lies in the fact that the results cannot be generalised to a wider scale as variation in characteristics across countries tends to be substantial. Furthermore, with the less-advanced statistical techniques used in the case study methodology, the results are not as powerful as research employing more complicated econometric strategies like regression analysis. Fardmanesh (1991) is one of the first authors to use time-series analysis, in a sample of five oil-exporting development countries. In his effort, he relates oil revenues to the shares of manufacturing and agricultural output in non-oil GDP. Surprisingly, he reports evidence that the manufacturing sector expands following an increase in oil revenues while the agricultural sector contracts in four of the five countries. As explanation, he introduces the *world price* effect, which states that world manufacturing prices rise relative to agricultural prices because of the oil price increases after the windfall. This rise in world manufacturing prices causes the manufacturing sector to expand.

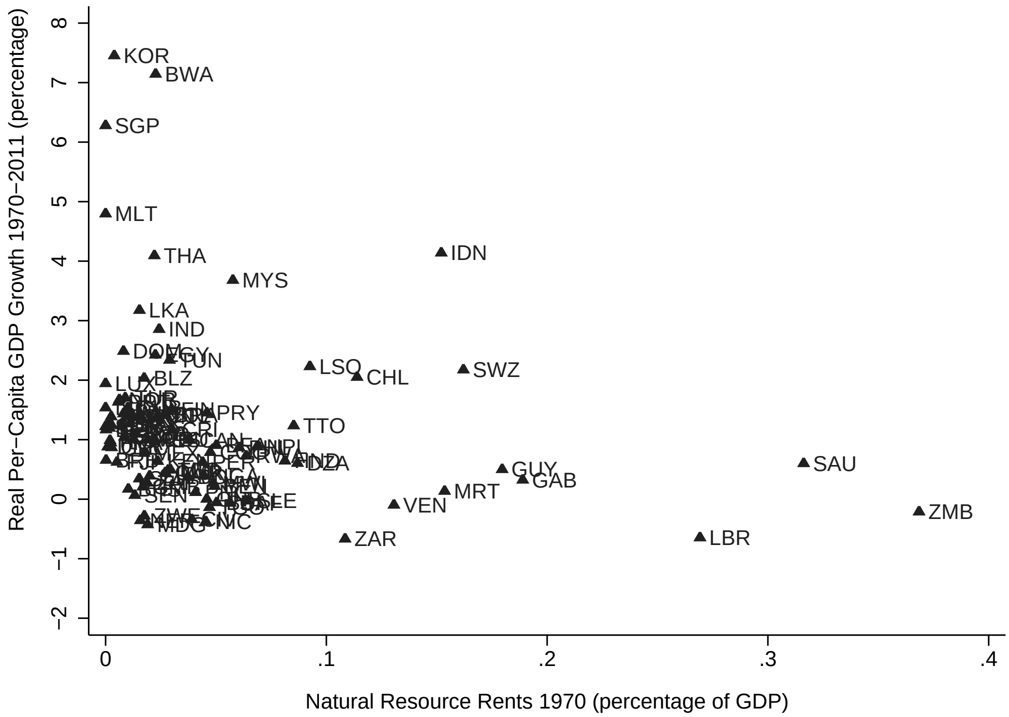
Spatafora and Warner (1999) investigate the Dutch disease effects on a slightly larger scale using regression analysis. Their work focuses on shocks in terms of trade, which they use for their analysis on the market effects. Examining data on 18 oil-exporting economies for the period 1965-1989, they fail to report evidence on a contraction of the manufacturing sector in response to terms-of-trade shocks. On the contrary, evidence for the spending effect is found, indicating higher price levels in the non-traded sectors of the oil-exporting countries. The latter result is also found by Sachs and Warner (2001) who employ a cross-sectional regression analysis using an even broader dataset of 99 countries. In their specification the relative price level is regressed on income per capita and the share of primary exports in GDP. Parsimonious as their specification is, they note this result provides only some evidence and a merely a first step towards further explaining the effects on cross-country competitiveness. Additionally they report a strong negative correlation between resource intensity at the beginning of the sample period and the growth in value-added from manufacturing exports over the entire period. Again, a simplified specification is adopted aimed at providing exploratory basis for further research. Stijns (2003) attributes contradicting results in the Dutch disease literature to insufficiently powerful and exogenous tests, which are the result of lack of data used in prior literature. Of the mechanisms of the core model, his work solely focuses on a potential fall in manufacturing output, proxied by manufacturing exports for the period 1980-1997. To control for other factors influencing trade, he applies the theory to a gravity model in which he includes world energy prices, as measure of resource abundance. His findings show that a one percent increase in energy prices lowers real manufacturing exports by half a percent, all else equal. As robustness he also examines the effect of net energy exports instrumented by the world energy price on manufacturing exports, for which he finds a similar result.

2.2. Political and institutional factors of the resource curse

With the influential works of Gelb (1988) for oil-abundant economies, and Auty (1993) focussing on mineral-intensive economies, research also started to shed light on political and social factors explaining the resource curse. In their pioneering empirical work Sachs and Warner (1995) employ the cross-country growth equations introduced by Barro (1991) on worldwide dataset. Using this framework they estimate the effect of resource abundance in 1970, measured as share of primary exports in GDP, on the growth rate over the entire period 1970-1989. The introduction of this strategy set off a large volume of other works examining the resource curse thesis, of which the typical result is represented in figure 2 for the period 1970-2011. Although the adverse relationship is not very strong It can be clearly derived from this figure that resource-rich countries like Venezuela, Gabon and Liberia all experienced substantially lower growth rates compared to resource-poor countries like Korea, Singapore and Malta.

In the original paper, Sachs and Warner (1995) show that countries with a higher share of primary exports to GDP at the beginning of the sample period, experience slower growth over the entire period, even after controlling for trade openness, investment and institutional quality amongst others. As a robustness check, other measures of resource abundance, including the share of resource output in GDP are also applied, leading to the same results. As a small side step, they report evidence of slower manufacturing sector growth in resource intensive economies, albeit the authors state that the evidence is imperfect due to limited data. As main channel however, they investigate the potentially detrimental effects on openness, investment, and rule of law, to examine whether resource wealth leads to protectionism and poor government efficiency. It is shown that resource intensive countries score lower on both institutional quality and trade openness, potentially corroding economic growth. Other studies that report a similar detrimental effect of natural resources include Gylfason et al. (1999)

Figure 2: Natural resource rents and economic growth



Source: World Development Indicators 2013, World Bank

and Gylfason (2001), who introduce a negligence of education as additional transmission channel, and Sachs and Warner (2001) in a summary and extension of their earlier work on the curse. Sala-i Martin and Subramanian (2003) highlight the detrimental effects of natural resources in a paper combining a global cross-sectional framework with a case-study on the effects of oil wealth in Nigeria. The global analysis focuses on deterioration of institutional quality while the analysis within oil-producing Nigeria points at waste and corruption leading to suboptimal economic performance.

Building further on the framework of Sachs and Warner (1995), Mehlum et al. (2006) confirm the initial findings. Instead of focusing on the effects of resource abundance on institutions, the authors show that the detrimental effects depend primarily on the type of institutions a country possesses. On the one hand, countries with *grabber-friendly* institutions, allowing more rent-seeking behaviour, and higher levels of resource abundance appear to have lower per capita income levels. On the other hand, per capita GDP seems to be higher in resource-rich countries possessing *producer-friendly* institutions, promoting output stimulating activities. This contradicts the original finding by Sachs and Warner (1995) that institutional quality does not seem to make a difference. In the set-up of

Mehlum et al. (2006), a cross-section dataset containing 87 countries is used with growth rates over the sample period 1965-1990. Their institutional quality variable consists of an unweighed average of five indexes: rule of law, bureaucratic quality, corruption, expropriation risk, and a repudiation of contracts index. This results in an indicator ranging from zero to one, zero representing grabber-friendly institutions and one indicating producer-friendly institutions. The indicator is interacted with the resource abundance measure to obtain the results. Boschini et al. (2007) take this analysis one step further by distinguishing between types of natural resources. They find similar results as Mehlum et al. (2006) for the natural resource term interacted by institutional quality, however the effects are shown to be larger for diamonds and precious metals than for other minerals. They refer to this combination of type of resource and institutional quality as the *appropriability* of a resource. These results suggest natural resource effects should be framed as *proximate causes* of economic growth. In that case, their effect ultimately depends on differences in *fundamental causes* like legal, political, cultural, and institutional factors (Acemoglu, 2009).

A further topic of debate in this field stems from the choice of indicator for resource wealth. Most of the earlier influential work employs the share of natural resource exports in GDP in the base year of the sample period to this end. This choice can be seen as problematic due to the endogeneity issues that are related to the construction of this measure. According to Brunnschweiler and Bulte (2008), the share of resource exports should be interpreted as an indicator of resource *dependence* as it measures the part of the total economy which is generated by resource exports and hence an indication of how dependent the country is on that part. High dependence results in low diversification of the economy which implies slower growth according to Arezki and Van der Ploeg (2011). Endogeneity issues further arise because the denominator of the ratio, GDP, is not independent of the institutions and policies specific to that country. For that reason, Brunnschweiler and Bulte (2008) argue that resource stocks are more suited for examining the resource curse. In their paper they employ *natural capital*, a measure encompassing a broad category of resource stock indicators from the World Bank, and mineral resource assets in a cross-sectional set-up covering 1970-1989. Surprisingly, using a measure of resource abundance instead of dependence shifts the results from a resource curse to a resource blessing, contrasting the original results by Sachs and Warner (1995). Furthermore, the measure of resource exports is re-examined using an instrumental variable approach with trade openness and a dummy for presidential system as instruments. Employing this set-up, evidence is found for neither a curse or a blessing, undermining the commonly accepted findings of earlier research.

Little attention has been given yet to the use of panel-data techniques to examine the resource curse thesis. The first attempts were conducted by Manzano and Rigobon (2001) who show that the original results from Sachs and Warner (1995) are not robust to changes in empirical strategy. To come to this result the authors construct two datasets, one with 2 time elements and one with 4 time elements. The variables used are the same as Sachs and Warner (1995). Contrary to the latter work, the authors now find the adverse effects of primary exports on growth to be insignificant. They argue that the negative effect found in the seminal work is due to the high commodity prices in the 1970s which were used as collateral for financing. The fall of commodity prices in the 1980s vaporized this collateral leaving serious debt problems for the developing countries which accumulated a lot of debt in this period. Harding and Venables (2010) study the relation between foreign exchange windfalls, induced by resource revenues, and non-resource exports, imports and the capital account, using a dataset of 133 countries for the years 1975-2007. They find that an increase in natural resource exports by 1 percent leads to a decrease in non-resource exports of 0.5 percent, and an increase in non-resource imports of 0.15 percent. This is interpreted by the researchers as some evidence for the Dutch disease effects. Mavrotas et al. (2011) focus on economic performance in 56 developing countries for the period 1970-2000. They distinguish between export data on point-source resource, such as oil and minerals, and diffuse resources such as agricultural products. The main results imply that point-source resources in particular seem to hamper economic growth and institutional quality in low-income countries. Other panel-data studies include Ross (2012) who finds no evidence for a significant effect of per capita oil income levels on economic growth.

2.3. Regional effects of resource wealth

More recently, research shifted towards regional effects of resource richness. One example is Dube and Vargas (2008), who relate shocks in coffee and oil prices to the prevalence of conflict in the region. Caselli and Michaels (2013) show that Brazilian oil-rich municipalities have higher levels of revenues and public spending while the effects on welfare for the local population appear to be insignificant. The effects of resource wealth in the United States are investigated by Papyrakis and Gerlagh (2007). To come to these results, the authors adopt cross-state growth regressions for the sample period 1986-2000. The share of primary output in state income is used as measure of resource abundance, which is shown to have a negative impact on growth in the sample period. This effect however subsides as more control variables are included. Turning to transmission channels, the authors find that resource abundance decreases investment, schooling, openness, and research and development expenditures, while corruption is increased. Subsequently it is shown that these indirect effects impair the economic growth across states. Michaels (2011) examines the development of oil-abundant counties in the Southern U.S. states which where significant deposits where discovered over the course of the sample period 1890-1990. His strategy entails the comparison of oil-abundant counties, located above an oilfield containing at least 100 million barrels before first extraction, to counties without substantial oil deposits. The main findings include that the oil-abundant counties hold higher densities of mining, manufacturing and agricultural employment, population growth and income per capita, during periods of the total time span. The explanation that is brought forward states that the higher levels of employment are caused by population immigrating to the oil-abundant counties.

Papyrakis and Raveh (2012) are one of the first to focus on Dutch disease market linkages on a regional level, using a panel-data set-up. Looking at the Canadian provinces and territories their paper aims to investigate the local and spatial impacts of resource booms in the period 1984-2008. The formal model by Corden and Neary (1982) serves as baseline for the specifications tested. As proxy for resource abundance, they multiply the share of mineral sector production at the beginning of the sample period by the average level of crude oil prices for each year. Since the crude oil price is largely determined by world markets, and the share of mineral production is held constant, they claim that their proxy is rather exogenous to province-specific factors. Exploiting this strategy they report that resource windfalls are associated with higher price levels, and shifts of labour away from the manufacturing sector. Furthermore they find that resource windfalls in neighbour provinces result in a shift of labour towards the manufacturing sector in the source region. In a complementary study Beine et al. (2012) find that 33 to 39 percent of manufacturing employment loss due to exchange rate developments is attributable to Dutch disease mechanisms in Canada.

2.4. Limitations of estimating the resource curse

The majority of the previous literature on the resource curse suffers from a number of econometric problems, in particular issues related to endogeneity. It is important to note that some of the limitations that have been identified by the related literature described above, will not be covered in this paper. Instead, I focus on the following two shortcomings, both which lend support the identification strategy which I adopt in this research. First of all, several pitfalls stem from the single cross-sectional regressions, typically employed as strategy in this field of research. This strategy usually consists of exploiting the variation in resource abundance at the beginning of the sample period, to explain differences in the average growth rates of income ($y_{i,t}$) across countries over the entire sample period. The problem of this approach lies in the assumption that the explanatory variables are not correlated with the individual effects (η_i) of a country. However, this assumption is violated in the case of a dynamic specification including a lag of the dependent variable ($y_{i,t-n}$) as explanatory variable. This is the case since several factors which could possibly determine economic growth, are specific to a country. Examples are the aggregate production function, cultural preferences, and the level of capital deepening of a country (Islam, 1995). These factors are often difficult to measure, or simply unobservable. For that reason, they end up in the country-specific effects. For the assumption of no correlation between η_i and $y_{i,t-n}$ to hold, $E[\eta_i y_{i,t-n}] = 0$ must not be violated. This cannot be the case however as $y_{i,t-n}$ is also a function of it's own lag $y_{i,t-2n}$ and the same individual effect η_i amongst others.

The variable $y_{i,t-n}$ is thus correlated with the fixed effects in the error term by construction. In other words, the term $y_{i,t-n}$ also includes η_i in $E[\eta_i y_{i,t-n}]$. Since $E[\eta_i^2] \neq 0$, it follows that $E[\eta_i y_{i,t-n}] \neq 0$. This results in omitted variable bias for the predicted estimates (Caselli et al., 1996).

A further limitation in studying the effects of resource abundance lies in the different experiences of resource wealth on a global level. A great heterogeneity in all of the explanatory variables can be observed across countries. This includes factors like institutional quality, technological progress, language, cultures, and monetary and fiscal policies often determined on a national level, that are often difficult to control for in an empirical framework. Furthermore countries often have different definitions and methodologies for obtaining data on various economic and natural resource variables. Altogether, these factors can have a confounding effect in estimating the impact of resource wealth on a global level (Van der Ploeg, 2011). Regions, and countries in particular, tend to show less variation in these confounding factors within their borders (Barro and Sala-I-Martin, 1995). For that reason an analysis of the resource curse thesis and Dutch disease mechanisms within a country could potentially increase the efficiency of the identification when compared to cross-country frameworks. The aim of this paper is to counter these limitations, at least for a part, by applying two dynamic panel-datasets. This framework will be tested on both a global and a regional scale, resulting in a paper consisting of two parts, much like the work by Sala-i Martin and Subramanian (2003). The formal model which provides the foundations for this strategy is described in the next section.

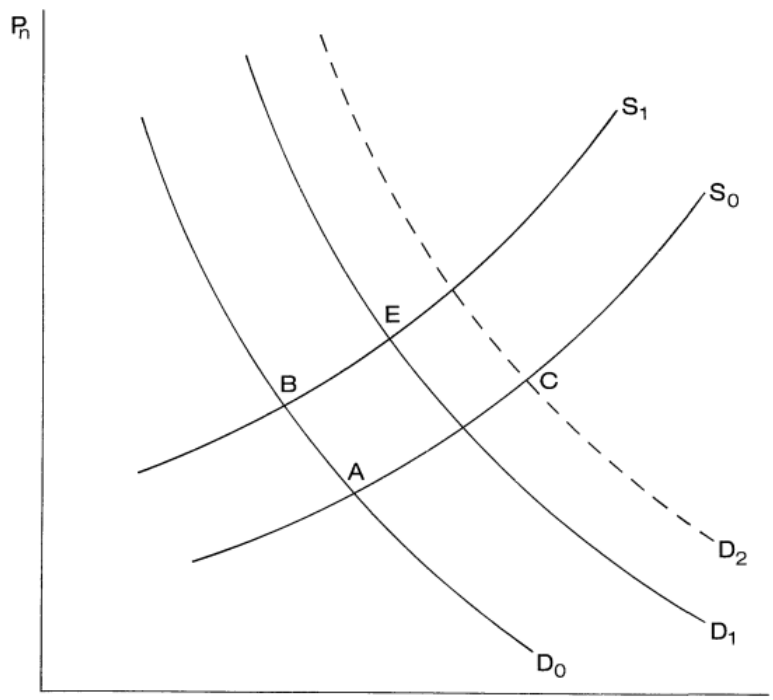
3. Theoretical foundations

3.1. The core model

The framework by Corden and Neary (1982) explaining the adverse effects of natural resources, considers a small open economy which distinguishes between three different sectors: a traded natural resource sector, a traded manufacturing sector, and one non-traded service sector. The assumption of a small open economy is essential to allow natural resources and manufacturing goods to be traded at exogenously determined world prices, while services are sold at flexible prices driven by domestic supply and demand solely. Natural resources and manufacturing goods are traded internationally, services are not sold across the border. Whenever a boom in the resource sector occurs, returns to the mobile factors employed in this sector rise. This results in two effects in the domestic economy: a *resource movement* effect and a *spending* effect.

The *resource movement* effect occurs due to an increase in factor returns in the resource sector, which causes an increase in factor demands. As a result, resources are shifted away from the manufacturing and service sector towards the more lucrative resource sector. The drop in employment of the manufacturing sector can be seen as *direct de-industrialisation* of the economy. This is shown in

Figure 3: Dutch disease mechanisms



Source: Corden (1984)

Figure 2, where P_n denotes the price of the service sector relative to the price of the manufacturing sector. The supply curve is obtained by the transformation curve between the non-traded good and the two traded goods, and the demand curve shows demand for the non-traded good at different relative price levels. The shift of resources away from the non-traded sector, as shown by moving from S_0 to S_1, causes excess demand for services after the boom. Therefore prices in that sector increase relative to the traded sectors resulting in a appreciation of the real exchange rate, amplifying the loss of the economy's competitiveness.

Further deterioration of the economy occurs due to the *spending* effect. This mechanism is fuelled by the direct effects of spending the extra income generated from the boom in the resource sector. When part of this extra income is spent by consumers or the government, the demand curve raises from D_0 to D_1. This results in prices in the non-traded sector to increase relative to the fixed prices in the traded sector. As the latter are exogenously determined by world prices and therefore assumed constant across countries, an appreciation of the real exchange rate occurs, depressing the competitiveness of the economy. Ultimately both effects imply an appreciation of the real exchange rate, from point A to point E in figure 2, and a contraction of the traded manufacturing sector. The fact that positive externalities from the manufacturing sector are lost this way cause an additional harm to the domestic economy. For further elaboration and extensions to the core model, I refer to Corden (1984).

3.2. Hypotheses

From the related literature on the resource curse and the theoretical framework, three potentially harmful effects can be identified. These will form the basis for the hypotheses which I will test in the remainder of this study.

I. *Resource abundance leads to slower economic growth in the short run*

II. *Shifts of resources away from manufacturing result in a contraction of that sector*

III. *Resource wealth will result in an appreciation of the relative price level*

The econometric framework outlined in the next section will be used to investigate the prevalence of these potentially deteriorating effects.

4. Empirical strategy

4.1. Specification

A dynamic panel-data approach is adopted to deal with the limitations of using single cross-section growth regressions. A dynamic panel-data model allows for the unobserved cross-country differences to be considered in the form of individual country effects (Islam, 1995). Omitted variable bias that results from the use of a cross-sectional framework is decreased by including factors like aggregate production functions, capital deepening, and technological differences in the individual fixed effects of the model. Instead of static levels of growth-enhancing factors like institutional quality, the dynamics of these variables can now be taken into account in the analysis. Furthermore, using panel-data increases degrees of freedom and sample variability, boosting the efficiency of the estimates. The benefits of a panel-data framework are also recognised by Manzano and Rigobon (2001) and Van der Ploeg (2011). The latter of these scholars argues, in his survey on the resource curse literature, that future studies on the curse should shift towards panel-data.

The foundations for the dynamic panel-data model used in this paper stem from the cross-country growth regressions used in the vast majority of the empirical literature, for example Sachs and Warner (1995). Islam (1995) adapts this baseline model to accommodate a panel-data framework. I adjust this model further to fit the testing of natural resource wealth effects. The resulting regression model is specified by equation (1a), which allows for the testing of hypothesis I.

$$\ln y_{i,t} = \alpha + \beta_1 \ln y_{i,t-1} + \delta_1 x_{i,t} + \theta_1 \mathbf{Z}_{i,t} + \eta_i + \zeta_t + \nu_{i,t} \tag{1a}$$

Here, the logarithm of the per capita income y of country i at year t is explained by the logarithm of the lagged level of income per capita $y_{i,t-1}$, a measure of resource abundance x, a set of time-variant other regressors $\mathbf{Z}_{i,t}$, a country-fixed effect η_i, a time-fixed effect ζ_t, and an idiosyncratic error term $\nu_{i,t}$. The main goal of this research is to re-examine the magnitude and sign of δ_1. The dynamic character of this specification implies that δ_1 represents also the estimated effect of resource richness on short-run economic growth. To see why this is the case, consider specification (1a) with $\ln y_{i,t-1}$ deducted from both sides of the equation. This results in an equation represented by (1b).

$$\ln y_{i,t} - \ln y_{i,t-1} = \alpha + (\beta_1 - 1) \ln y_{i,t-1} + \delta_1 x_{i,t} + \theta_1 \mathbf{Z}_{i,t} + \eta_i + \zeta_t + \nu_{i,t} \tag{1b}$$

The left-hand side of now results in $\ln y_{i,t} - \ln y_{i,t-1}$, which can be rearranged as $\ln \frac{y_{i,t}}{y_{i,t-1}}$. This latter term is equivalent to the growth rate of y over the period $t-1$ to t, and hence can be interpreted as the short-run growth rate. To minimize the possibility that the effect of resource wealth on income growth is driven by other factors, a set of control variables is applied. These variables are selected in accordance with factors commonly found to have an effect on a country's growth rate. A description of these covariates and their sources can be found in section 5. Including this control set, δ_1 now represents an estimate of the average effect of resource wealth x on the rate of income growth in the short run, holding all other covariates constant.

The above described resource-movement effect from the model of Corden and Neary (1982) is estimated using specification (2).

$$\ln y_{i,t}^{Man} = \alpha + \beta_2 \ln y_{i,t-1}^{Man} + \delta_2 x_{i,t-1} + \theta_2 \mathbf{Z}_{i,t} + \eta_i + \zeta_t + \nu_{i,t} \tag{2}$$

This specification is partly similar to specification (1a), except for the income level which is now limited to the manufacturing sector. A further difference is the indicator of resource wealth which is now included for period $t-1$, as I assume it will take some time before labour and capital are shifted towards the resource sector. Evidence for a contraction of that sector is found in case of a negative sign of δ_2. As convergence effects could play a role in the manufacturing sector as well, a lagged variable of income, $\ln y_{i,t-1}^{Man}$, is included. This implies that δ_2 is also an estimate of the effect of resource abundance on the short-run growth of the manufacturing sector, similar to specifications (1a) and (1b). Again, a control set is included in this regression, described in section 5.

Finally, the spending effect is tested. According to this effect, the spending of extra revenues generated by the resource sector, raises prices in the non-traded sector. At the same time the prices in the traded sector, determined by the world-market prices, logically remain constant relative to other countries. As relative price levels of the non-traded sector are generally not available, the general price level relative to other countries is employed as dependent variable. The argumentation behind this is the fact that an increase in the non-traded prices in combination with traded prices remaining equal, implies an increase in the general price level. This can be concluded from the fact that the general price level is calculated as the average of the two (Sachs and Warner, 2001). This results in equation (3).

$$P_{i,t} = \alpha + \gamma_3 P_{i,t-1} + \delta_3 x_{i,t-1} + \theta_3 \mathbf{Z}_{i,t} + \eta_i + \zeta_t + \nu_{i,t} \tag{3}$$

Here, $P_{i,t}$ reflects the price level of country i at year t, relative to the U.S. price level. A positive sign of δ_3 gives an indication that higher price levels could be driven by the spending effect in countries endowed with relatively higher amounts of natural resources. In this model, the country's relative price level is a function of its lagged value, an indicator of resource wealth, and a set of control variables. Again resource wealth is included for period $t-1$ as I assume prices are sticky, which implies it will take some time before they adjust to shocks in resource wealth.

4.2. Estimation technique

Estimating the effects of resource wealth on economic development gives rise to several endogeneity issues. Biased estimates due to omitted variables and measurement error cannot be fully ruled out, but perhaps the most significant issues are related to reverse causality. Causal identification is especially challenging due to the fact that resource wealth does not appear to be purely exogenous. Natural capital, in the purest sense of the word, can be considered as randomly distributed over the world. However, indicators of pure natural capital are not widespread and resource wealth is often measured in production, income or export values. In the chain of discovery, extraction, production, and marketing of natural resources a multitude of other factors play a role. Combined, these economic and political factors could very much influence the measurable wealth of resources in a country. As a consequence, resource richness cannot be considered to be randomly distributed, but rather a function of three variables: geological endowments, investments needed for extraction, and lastly world commodity prices. The latter, which can be considered similar for all countries, most likely influences the rate of extraction and potential revenues (Ross, 2012). One solution to this problem, would be to use an exogenous instrumental variable which influences the dependent variable only through its effect on the measure of resource wealth. This approach would allow filtering the exogenous part of resource abundance out, which in turn can be exploited to estimate the unbiased effect of the endogenous variable. It is however very challenging to find a convincing instrument which impacts economic growth only through its effect on resource wealth. Options which fit this picture are simply not widespread available. For that reason, this approach is not adopted in this study.

A further issue arises with the presence of lagged dependent variables in the regressions models, as is the case in specifications (1a), (2), and (3). Since the lagged variable is a function of the dependent variable, which in turn is a function of the error term, the lagged variable is correlated with the error term by construction. As a result, estimation using a straightforward panel-data estimator is biased and inconsistent, since the strict exogeneity assumption ($E[\nu_{i,t}|y_{i,t-1}, x_{i,t}, \mathbf{Z}_{i,t}, \eta_i, \zeta_t] = 0$, in case of equation (1a) no longer holds (Baltagi, 2008). While the fixed-effects (FE) estimator can be used to get rid of the country specific effect η_i, the lagged dependent variable will still remain correlated with the idiosyncratic error term, $\nu_{i,t}$. Therefore the FE estimator is consistent yet still biased depending on the size of the sample period, as is shown by Nickell (1981) and more recently by Kiviet (1995). This bias approaches zero as T, the number of time periods, approaches infinity. With 31 time dimensions in the global dataset and 25 in the U.S. dataset, the panels used in this study can be considered relatively large. However Judson and Owen (1999) find that the dynamic panel bias still amounts to 20% of the true effect in a sample of 30 time periods. Therefore, the FE estimator is less appropriate for this study.

An alternative way to deal with the above mentioned issues lies in the use of estimators which employ internal instruments that are uncorrelated with the fixed effects of the error term. As convincing external instruments are often not readily available, this approach utilizes lagged values of the endogenous variables themselves to filter out the exogenous effect (Roodman, 2009a). These instruments can be applied either in levels or transformed by differencing. In the case of dynamic framework, including y_{t-1} as explanatory variable, y_{t-2} can be used as instrument for example[1]. This is the case as $y_{i,t-2}$ is related to $y_{i,t-1}$ but not to the idiosyncratic error term, $\nu_{i,t}$ of the original model[2]. Applied in a two-stage least squares regression, the inclusion of lagged values as instruments leads to a consistent estimator, called the Anderson-Hsiao estimator (Anderson and Hsiao, 1982). In principle, the efficiency of this estimator increases with the amount of lags. The downside however is that the sample size decreases as observations for which lagged values are missing are dropped from the regression.

The latter problem can be overcome using a Generalized Method of Moments (GMM) approach, as is done by Holtz-Eakin et al. (1988). Contrary to entering the instrument into a single column, they apply a set of instruments from the lagged value for each time period. In addition, missing values are replaced by zeros resulting in GMM instruments. This results in a vector of GMM instruments stacked in multiple columns, increasing the number of usable moment conditions and solving the problem of small sample periods (Roodman, 2009a). While estimates are more efficient and consistent using this

[1] If the specification is differenced, Δy_{t-2} would be the appropriate instrument.

[2] An important note is that for this notion to hold, $\nu_{i,t}$ should not be serially correlated.

methodology, estimation using two-stage least squares cannot be considered accurate any longer as the error terms in the differenced specifications both include $\Delta\nu_{i,t-1}$ giving rise to autocorrelation. Using the Arellano-Bond estimator (Arellano and Bond, 1991) the autocorrelation issues can be mitigated. In their framework, the full specification is first differenced to get rid of the individual effects η_i which are assumed to be correlated with the right-hand side variables. Subsequently, using the GMM approach, all past information from the lagged values is used as instruments to capture the exogenous effect of the predetermined and endogenous variables. This is called difference GMM estimation.

Alternatively, additional moment conditions can be obtained if the assumption is made that the right-hand side variables are uncorrelated with the individual effects η_i. This approach yields valid instruments for both the untransformed level equation and the first-differenced equation (Bond, 2002). As this assumption is very strong, Arellano and Bover (1995) and later Blundell and Bond (1998) develop a framework in which the first-differences of the right-hand side variables ($\Delta x_{i,t}$) instead of the level are assumed uncorrelated with the individual effects. They use the lagged values of the first-differenced variables as instruments. The additional moment conditions from this approach further boost efficiency, and result in an estimator referred to as the Arellano-Bover/Blundell-Bond estimator or system GMM. Due to its performance in estimating dynamic panel-data models, the system GMM estimator will be adopted for the identification framework of this study. The system GMM model can be estimated using the one-step and two-step estimator. The two-step estimator uses a standard covariance matrix which is robust to panel-specific autocorrelation and heteroskedasticity. This makes the two-step estimator more asymptotically efficient (Roodman, 2009a). Both estimators will be employed as measure of robustness of the configuration of the system GMM framework.

5. Data

In the first part of the analysis, the empirical framework is applied to a global scale. To this end, a new dataset is constructed covering 163 countries for the period 1980-2011. Estimating the effects with this dataset allows for a re-examination of the resource curse thesis, and the Dutch disease effects through which the curse potentially manifests itself. Section 5.1 describes the dependent variables and the measure of resource abundance, while section 5.2 presents the set of control variables. Section 5.3 shows the descriptive statistics for these variables. The labels used in the dataset which correspond to the variables described in this section are displayed between brackets.

5.1. Market effects and natural resource data

For each country, income levels are collected from the World Bank (2013) *World Development Indicators* and divided by population levels. All income data is measured in 2005 U.S. Dollars to eliminate variation due to price-level changes. This results in a measure of real income per capita (*gdpc*). Income data for the manufacturing sector level is available as manufacturing sector value-added (*yman*), also obtained from the World Bank (2013). This indicator measures manufacturing sector output from industries belonging to ISIC divisions 15-37. Value added is obtained by deducting intermediate inputs from the output levels of these industries. Finally, the spending effect is measured by examining the impacts on the relative price levels of a country. In the formal model, the spending effect occurs in the non-traded service sector. This results in an appreciation of the non-traded prices compared to traded prices, which is the equivalent of an appreciation of the real exchange rate of a country. Unfortunately, extensive real exchange rate data for every country in time-series is not directly available. For that reason, I choose to exploit the general price level of a country relative to U.S. prices (*price*), along the lines of Sachs and Warner (2001). They argue that traded price levels are roughly equivalent across countries. An increase in non-traded prices thus amplifies the general price level as this is a combination of traded and non-traded prices. They obtain the relative price levels of countries by the ratio of a country's GDP in U.S. Dollars measured by local current prices and multiplied by the nominal U.S. Dollar exchange rate, to the same GDP level in international prices, $\frac{y*P/E}{y*P\$}$. Due to data availability I use a slightly different method from Feenstra et al. (2013). Along that line, relative price levels are calculated by dividing a country's purchasing power parity (PPP) by its nominal exchange rate per U.S. Dollar, which results in the price level of a country relative to U.S. prices.

Finding a good measure of a country's resource wealth is one of the most challenging tasks in the design of this research. First of all, clear boundaries need to be set on which commodities can be considered a natural resource. Second, approximating the total natural resource capital of country involves significant costs and technical difficulties. This is the main reason for scarceness of data on resource endowments. An indicator which perhaps is the closest approximate of resource wealth is *natural capital* from the World Bank. However, this indicator is only available for the years 1995, 2000, and 2005 and therefore inadequate for the empirical strategy I adopt for this study. The only stock indicator available in time-series, is *proven reserves* of crude oil and natural gas from BP's *Statistical Review of World Energy* and the U.S. Energy Information Administration. However, this data would limit the study to the effects of oil and gas wealth and is therefore less appropriate, as the initial focus of this study is overall natural resource wealth. As alternative, I use a country's total natural resource rents per capita as explanatory variable (*rtot*). This measure includes the combined rents of crude oil, natural gas, coal, other minerals, and forests. Rents are defined as the price of a commodity minus the costs of extraction, multiplied by the total amount of the extracted resources. Data is take from the World Bank (2013). The drawback of this indicator is that it is measured as a share of GDP.

While this allows for the comparison of rents across countries, the indicator is also determined by the size of GDP. The advantage however, is that the data is widely available in time-series from a reliable source. Furthermore, one of the most used indicators, the share of natural resource exports to GDP, is influenced by a country's openness to trade, and domestic sales are not taken into account. These issues are mitigated by using the share of natural resource rents in total GDP.

5.2. Control variables

It might be the case that the effects of resource wealth on the dependent variables are correlated with another unobserved effect that influences GDP growth. This can lead to a potential bias in the estimated coefficient of resource wealth. To prevent this form of endogeneity, different control variables are added to the empirical model, represented by the vector $\mathbf{Z}$. A vast amount of variables are available from the growth regression literature. For this study, I choose the ones which are represented in most of the influential work on growth empirics.

Since the level of institutional quality is widely assumed to be a fundamental cause of economic growth, a control variable for this factor is included in the dataset. Sound institutions are thought to facilitate and stimulate the practice of growth-enhancing activities. One problem with this concept is the difficulty to define and measure levels of institutional quality. Still, several alternatives are available. For this research, institutional quality is measured by the revised combined *polity* score from the *Polity IV Project* by Marshall and Jaggers (2012). This represents a composite indicator combining institutionalized autocracy and democracy scores of country. In turn these indicators are made up of the scoring on competitiveness of executive recruitment, openness of executive recruitment, constraints on chief executives, and competitiveness of political participation. Combined they form a scale, *polity*, ranging from +10 for strongly democratic countries and -10 for strongly autocratic countries. While this is primary a measure of political freedom, it can be assumed that countries with high scores have a high level of institutional quality, and vice versa. Furthermore, the Polity IV variable is the only indicator with next to complete time-series dating back to the beginning of my sample period.

According to popular growth theory, the level of human capital is also considered to be a driver of economic growth. Romer (1990) for example, argues that the technological progress which drives growth is ultimately fuelled by human capital. The level of human capital is proxied by the ratio of total secondary school enrolment to the population of that age group (*school*) (World Bank, 2013). In the endogenous growth model, the investment ratio of a country also has a positive effect on growth. A higher investment rate is equivalent to a higher savings rate, raising the steady state level and thus growth rate of a country (Barro, 1996). The investment ratio is also included in the model, and the variable is collected from the World Bank (2013) in the form of capital formation as percentage of

GDP (*inv*). According to the Solow model, population growth should have a negative effect on the level of capital per work and thus income. Therefore a variable measuring this growth rate (*popg*) is included as a control variable. This is again obtained from the World Bank (2013). Following Sachs and Warner (1995) a variable for the openness of a country towards international trade (*open*) is included. In their research, the more a country is the openness of a country towards trade results in a positive effect on the economic growth rate. This indicator is calculated as the ratio of exports plus imports to GDP. This control is expected to be positively correlated with growth. Finally, a measure for the life expectancy of the population in years ($lifex$) is included in the dataset. This variable is also expected to have an enhancing effect on growth. I assume that if the labour force is more fit and has longer longevity, it is more capable of contributing to the growth of a country. As I assume that most of the factors which determine the rate of growth of an economy also have an impact on the growth rate of the manufacturing sector, a control set similar to the one for testing the effect on growth is adopted for the resource movement effect.

Several additional controls are added for testing the spending effect. All of these come from the World Bank (2013). An index for *terms of trade* (*tot*), is added, as shocks in export prices relative to import prices most likely influence the real exchange rate of a country. Excess money growth ($m2$) tends to increase the price of non-tradeables which is also associated with an increase in the real effective exchange rate. While government expenditure (*gexp*) is most likely spend on non-tradeable goods, growth in this indicator could also put an upward pressure on the relative price level of a country, and thus the real exchange rate. The same could be argued for public consumption expenditure (*cons*) (Lartey et al., 2008).

5.3. Descriptive statistics

The summary statistics for a selection of the variables used in this study are represented in table 1 for the global dataset. Besides the descriptives on the world scale, a distinction is made between resource-poor and resource-abundant countries, following the definition by Auty (1993). A country is considered resource-abundant if the share of aggregate income drawn from the resource sector equals 8 percent or more, and resource-poor otherwise. It can be drawn from table 1 that income levels on average are higher in resource-poor countries compared to their abundant counterparts. In absolute terms this difference is significant, $2,033.28 ($3,561.72 - $1,528.44). In other words, the average income is 133 percent higher in resource-poor countries.

While some people would see this as a first indication of the resource curse, it does not indicate anything more than that the average income level is higher in the countries with relatively little resource endowments, compared to their resource-rich counterparts. It does not tell anything about the effect of natural resources on the short-run growth rate of countries. While the income level is in

Table 1: Summary Statistics for the Country Data 1980-2011

	World		**Res. Poor**		**Res. Abundant**	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Log GDP per capita	7.858	1.629	8.178	1.617	7.332	1.510
Log manufacturing output per capita	1.205	0.686	1.395	0.685	0.883	0.556
Relative price level	0.547	0.315	0.580	0.338	0.492	0.263
Natural resource rents (% of GDP)	0.095	0.104	0.023	0.021	0.241	0.166

Notes: The majority of the data is collected from the World Bank (2013). For a full description of the data see section 5. Descriptive statistics for all variables included in this research can be found in the appendix.

principle a collection of all historic growth rates and thus this table raises the suspicion that resources have a negative effect, it can be the case that this effect has changed over the past time periods. Furthermore, the descriptive statistics show that on average the manufacturing output in resource-poor countries outweighs that of the resource-abundant countries. On first sight, this is in line with the expected resource-movement effect. The average price level relative to U.S. prices appears to be lower in the resource-abundant countries, this is not in line with the expected spending effect.

6. Results

This section reports the results of the main empirical analysis of this paper. Section 6.1 presents the results for the effect of resource wealth on economic growth. Section 6.2 shows the several robustness tests, and the results of the tests applied to different time-periods and different categories of resources. Section 6.3 examines the resource movement effect, followed by the spending effect in section 6.4. To concentrate on the most important findings of this study, a selection of the most relevant output is displayed. A full representation of all regression results can be found in appendix B of this paper.

6.1. The resource curse thesis re-examined

Table 2 shows the results of the statistical tests of the impact of natural resource wealth on short-run economic growth. I start with the one-step system GMM estimator for which the estimates are presented on the left side of the table. Specification (1a) represents the results of the model including the full set of control variables, and excluding year dummies. Since all of the covariates are potentially endogenous, they are included in the GMM instrument matrix. This is the case as causality can run in both directions of the specification. Developed nations for example, could be more capable of extracting natural resources from the ground, as they most likely have access to more sophisticated technological equipment. To ensure that the instruments are not correlated with the error term in the level equation, instruments starting from lag $t-2$ are applied. As noted in Roodman (2009b), caution is warranted in employing a large set of instruments to prevent the model from overfitting the endogenous variables. This would make the instruments less valid in filtering out the exogenous parts of the regressors. Generally, the instrument count should not exceed the number of observed individuals (Roodman, 2009a). For that reason, instruments are capped at lag $t-6$[3]. For all models the instrument count is reported below the estimates.

An important assumption of the adopted estimation technique entails validity of the employed instruments. To check this assumption, the Arellano-Bond test for autocorrelation and the Hansen test of over-identifying restrictions are applied, and the p-values of these tests are reported at the bottom of the table. The Arellano-Bond test for autocorrelation examines the null-hypothesis stating the absence of autocorrelation, which is tested on the models' residuals in differences. This test is applied on the first and second lag. Autocorrelation for the first order is expected as the differenced idiosyncratic error and its first lag both include the term $\upsilon_{i,t-1}$. However, the second lag should not be correlated with $\Delta\upsilon_{i,t}$ as this would imply that the second lag is endogenous and therefore not valid as an instrument. The Hansen test checks validity of the instruments by examining the hypothesis that the moment conditions are randomly distributed around zero. This is done by a Wald-test for which the p-values are reported at the bottom of the table. Since this statistic is inconsistent for the one-step estimator (Roodman, 2009a), p-values for the Hansen statistic are only reported for the two-step estimator.

Interestingly, the results of regression (1a) show that a higher share of resource rents in the economy appears to lead to higher short-run growth levels on average. According to the estimate, an increase in resource rents of 1 percentage point leads to an increase in short-run growth of roughly 0.291 percentage point. The standard error with a value of 0.043 is relatively small, indicating a relatively high accuracy of the estimate. The result holds even when other widely assumed determinants of growth are held constant. These findings contradict the original resource curse results by Sachs and Warner (1995). Their results indicate that countries endowed with a relatively large amount of natural resource could see their growth rates negatively impacted. The predicted effect from specification (1) however, shows that resource-rich countries could actually benefit from their natural wealth, considering the time

[3]The *collapse* function from *xtabond2* further reduces the number of instruments by collapsing the instrument matrices. This entails adding up the instruments horizontally, resulting in a single column of instruments. This makes the number of instruments linear in T as only one single moment condition is produced. Although the collapsed instrument set embodies the same expectation as the uncollapsed set, the downside is that it carries less information (Roodman, 2009a)

Table 2: Estimation of the Resource Curse

System GMM Estimates of the Effect of Resource Wealth on Income Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Lagged value of log GDP per capita	0.986***	1.052***	1.034***	0.993***	1.030***	1.014***
	(0.008)	(0.010)	(0.011)	(0.015)	(0.025)	(0.030)
Natural resource rents (share of GDP)	0.291***	0.434***	0.366***	0.280***	0.326***	0.297**
	(0.043)	(0.042)	(0.040)	(0.103)	(0.118)	(0.124)
*Nat. resources * Institutional quality*			-2.211***			-1.991
			(0.707)			(1.447)
Full control set included?	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies included?	No	Yes	Yes	No	Yes	Yes
No. of countries	142	142	142	142	142	142
No. of obs.	2653	2653	2653	2653	2653	2653
No. of Instruments	48	79	85	48	79	85
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.424	0.154	0.251	0.414	0.287	0.376
Hansen test, P-value	-	-	-	0.053	0.145	0.193

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

period under investigation. This could be an indication that over time the effects of resource wealth shifted from being detrimental towards growth-enhancing.

Model (2a) shows that the positive pattern is confirmed after the inclusion of time dummies[4]. In addition, the predicted estimate appears to be stronger under this set-up and now amounts to 0.434 percentage point. The result is significant at the one percent level, and the AR(2) test indicates the absence of autocorrelation for the second lag. This adds further support to the positive effect of resource wealth on the short-run development of nations found in this study. Interestingly, the convergence coefficient now points in the direction of divergence as the estimate is larger than one

[4] Adding a dummy for every year makes the assumption of no correlation between countries in the idiosyncratic error terms more likely to hold. The results of the models including these time dummies are therefore more robust compared to their counterparts.

and still statistically significant.

Models (1b) and (2b) are equivalent to their counterparts except for the fact that now the two-step system GMM estimator is used. As further robustness measure, Windmeijer-corrected standard errors (Windmeijer, 2005) are applied[5]. The results are approximately similar to their counterparts, thereby providing support to a positive effect of natural resource rents on short-run economic growth. The predicted estimates are slightly decreased however. Regression (1b) shows a coefficient of 0.280 percentage points. Regression (2b), including the control variables and time dummies, results in a predicted effect indicating a 0.326 percentage point higher growth rate on average after a 1 percentage point increase in resource rents. For the two-step estimation, the Hansen-test values are now also reported. For all models, the p-values clearly indicate that the hypothesis of joint validity of the instruments cannot be rejected. Altogether, the results of (1a), (2a), (1b), and (2b) all show a positive coefficient for the natural resource indicator. This appears to be further evidence for the notion that the negative effect of resource wealth on growth possibly shifted towards a positive effect.

Previous research has indicated that the degree to which natural resources impact the economy could depend on the quality of institutions of a country. For that reason, an interaction term composed of resource rents and the Polity IV variable is included in regressions (3a) and (3b). The interaction effect is added to the model containing all other covariates and the time dummies. The results under (3a) surprisingly show that the sign of the predicted coefficient is negative. This indicates that the positive short-run growth effect stemming from natural resources is on average lower in countries with higher scores for the Polity IV variable, the proxy for institutional quality. The estimate predicting the effect of natural resource rents is again positive. The magnitude is now slightly decreased to 0.366 percentage point and still significant at the one percent level. The interaction effect is not statistically significant any longer, when the more efficient two-step estimator with robust standard errors is employed in (3b). This result is more intuitive than the outcome of the interaction term in (3a), as I expect that sound institutions promote the effect of resources on growth. It could be the case that the negative interaction term is caused by the potential existence of outliers in the dataset. More specifically, countries with polity scores around the lower bound of the indicator, which at the same time produce relatively large amounts of natural resources, could drive the negative estimate found in the results. An example are the so called rentier states, where the largest part of the rents stemming from the production of resources end up in the hands of an authoritarian government. To test whether this phenomenon drives the negative interaction term, I perform a sensitivity analysis in

[5] This correction was developed to counter the fact that the regular two-step standard errors tend to be downward biased. As two-step estimations are considered asymptotically more efficient in general, this correction leads to more efficient estimates with accurate standard errors (Roodman, 2009a).

which the most apparent outliers are excluded[6]. The full results of this test are reported in table 24 of appendix C. It follows from these results that the exclusion of outliers in polity scores and resource rents does not alter the coefficient of the interaction term, both in sign and magnitude. Moreover, the coefficient of the interaction term is now also significant in the case of the two-step estimator. These results are counter-intuitive to the effects which are expected for the interaction term. As the outliers do not drive these results, it remains unclear what could be the cause of the negative sign found for the interaction term of institutional quality and natural resource rents.

6.2. Robustness and types of natural resources

In this subsection I check whether the results are robust to changes in the econometric framework and data. First, I test the specifications using the less sophisticated, but potentially biased, fixed effects estimator. Next, I test whether the results change when the original resource wealth indicator of Sachs and Warner (1995), the share of primary exports to GDP, is utilized. The results of both robustness tests are reported in section 6.2.1. Furthermore, I check if the results are driven by different time periods and different types of resources. The output of these tests is described in sections 6.2.2 and 6.2.3 respectively.

6.2.1. Alternative estimator and explanatory variable

The main reason for adopting the system GMM estimator in this study is that it produces consistent estimates even when a lagged level of the dependent variable is included in the model. Other estimators potentially suffer from dynamic panel-data bias, which decreases in the number of time periods. Since the number of time periods in my study is 31, it is worth checking the changes in results when different estimators are employed. To this end I apply the fixed-effects estimator to the dataset.

The results of the fixed-effects estimation are shown under (1), (2), and (3) of table 3. Specification (1) is a naive model including only the level of GDP per capita at $t-1$ and the share of resource rents in total GDP. In regression (2) the set of control variables is added, followed by the time dummies in model (3). Similar to the previous system GMM results, a significant positive coefficient is found for the relationship between natural resource wealth and short-run economic performance. Compared to the previous results, the magnitude is now smaller, ranging from 0.087 to 0.120 percentage point. This is most likely the consequence of the dynamic panel-data bias from which the fixed effects estimator suffers in this specification. This bias is negative in case of positive coefficients, which could be an

[6] To this end, the countries which have an average polity score of -7 or lower, and an average share of resource rents of 0.20 and higher over the sample period, are excluded from the dataset. The list includes Saudi Arabia, Qatar, Oman, Uzbekistan, Turkmenistan, Bahrain, Syrian Arab Republic, Iraq, United Arab Emirates, Bhutan, and Kuwait.

Table 3: Robustness Tests

Estimates for the Effect of Resource Wealth on Income

Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)

	Fixed-effects model			**System GMM**		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged value of log GDP per capita	0.974***	0.952***	0.934***	1.006***	0.975***	0.972***
	(0.004)	(0.006)	(0.006)	(0.002)	(0.015)	(0.016)
Natural resource rents (share of GDP)	0.087***	0.120***	0.063***			
	(0.014)	(0.020)	(0.021)			
Primary exports (share of GDP)				-0.012	0.208**	0.314**
				(0.126)	(0.104)	(0.151)
Full control set included?	No	Yes	Yes	No	Yes	Yes
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	163	142	142	156	131	131
No. of obs.	4569	2653	2653	3266	2116	2116
No. of Instruments	-	-	-	14	56	87
AR (1) test, P-value	-	-	-	0.000	0.000	0.000
AR (2) test, P-value	-	-	-	0.158	0.049	0.015
Hansen test, P-value	-	-	-	0.010	0.083	0.216
R-squared	0.944	0.955	0.960	-	-	-

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

explanation for the decreased coefficients reported in models (1), (2), and (3) (Nickell, 1981). Despite this difference in magnitude, the predicted effects again indicate that natural resources are potentially a blessing instead of a curse. The results of section 6.1 thus seem to be robust to changing the estimation method.

Models (4), (5), and (6) are similar in specification to (1), (2), and (3), except now the share of primary exports to GDP is used as explanatory variable. This is the same indicator of resource abundance that is used by Sachs and Warner (1995) in their seminal work. The models are now estimated using the system GMM estimator again, and the predicted estimates are reported in the right part of table 3. The output now again points toward a resource blessing, given the positive predicted estimates. The full model including control variables shows a coefficient of 0.208, compared to 0.314 for the model including time dummies. Both estimates are significant at the five percent level.

Again, the findings appear to indicate that short-run economic growth could be positively impacted by natural resource rents. It should be noted however that the p-values for the AR(2) test are relatively weak for model (6) including time dummies. It is therefore questionable whether the instruments used for this regressions can be considered valid.

6.2.2. Time periods

It could be possible that the counter-intuitive findings are driven by the choice of sample period. In particular, events or effects specific to a certain decade and omitted from the original regressions could be the reason why sometimes a negative correlation is found between resource wealth and economic development. In particular, the work by Sachs and Warner (1995) adopts a dataset covering the 1970s and 1980s as sample period. I check whether the predicted effect differs between time periods by adopting two different strategies. First, the dataset is divided in sub-datasets for every decade since 1970. For these time periods the system GMM tests including the explanatory variable of interest, full control set, and time dummies are conducted. The adopted two-step system GMM estimator with robust standard errors is configured in the same way as the original corresponding regression (3b) in table 2. The results for each decade are found under (1a), (1b), (1c), and (1d) in table 4.

Second, the full dataset is adopted and estimated with the addition of interaction terms which test for the interaction effect between dummies constructed for each decade, and natural resource rents. The advantage of the second approach is that the same fixed effects from the original estimations are used, except that now it can be drawn from the results whether specific decades impact the original positive coefficient which is found for the relation between of resource wealth on economic growth. The results of the latter strategy are produced using both the one-step and the two-step system GMM estimator with robust standard errors. The findings of these regressions are reported under (2a) and (2b). Since the years 2010 and 2011 fall outside of the tested decades, the original coefficient now reports the predicted effect for 2010-2011. The effects for the decades can be obtained by adding the interaction term for the specific decade to the original estimate for 2010-2011.

It can be drawn from the results from (1b) and (1c) that in the 1980s and 1990s the effect of natural resource rents on short-run economic growth has a negative sign. Particularly in the decade of the 1980s the negative effect was relatively substantial. In that decade, an increase of resource rents with one percentage point resulted in a slower short-term growth of 0.589 percentage point. The result is not statistically significant however, due to a relatively large standard error. Interestingly, model (1d) shows that the predicted effect of resource wealth on growth shifts to positive in the 2000s. With a coefficient of 0.275 percentage point the impact is substantial, and statistically significant at the one percent level. This could be a first indication that the positive effect found in the original models is particularly driven by a boost in resource rent growth during the first decade of the 2000s.

Table 4: Time periods

Estimates for the Effect of Resource Wealth on Income Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)						
	70-79	**80-89**	**90-99**	**00-09**	**1970-2011**	
	(1a)	(1b)	(1c)	(1d)	(2a)	(2b)
Lagged value of log GDP per capita	0.986***	0.995***	1.043***	0.985***	1.008***	1.008***
	(0.037)	(0.031)	(0.032)	(0.023)	(0.008)	(0.020)
Natural resource rents (share of GDP)	0.147	-0.014	-0.589	0.275***	0.262***	0.182**
	(0.093)	(0.119)	(0.404)	(0.092)	(0.043)	(0.075)
*1970s dummy * Nat. Resource rents*					-0.284***	-0.143
					(0.090)	(0.191)
*1980s dummy * Nat. Resource rents*					-0.254***	-0.178**
					(0.056)	(0.088)
*1990s dummy * Nat. Resource rents*					-0.077	0.044
					(0.071)	(0.151)
*2000s dummy * Nat. Resource rents*					0.056	0.105
					(0.045)	(0.067)
No. of countries	75	85	115	135	142	142
No. of obs.	563	647	742	916	3284	3284
No. of Instruments	57	57	57	57	97	97
AR (1) test, P-value	0.000	0.000	0.007	0.004	0.000	0.000
AR (2) test, P-value	0.276	0.004	0.449	0.232	0.017	0.114
Hansen test, P-value	0.138	0.113	0.263	0.010	-	0.457

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses. All estimated models include the full set of controls and year dummies.

Regression (2a), estimated using the one-step estimator over the entire sample period, shows that interaction terms for the 1970s, 1980s, and 1990s are all negative. Similar to the previous strategy, the effect shifts to positive for the 2000s. Regression (2b) shows similar results, except for the fact that the 1990s interaction term now also has a positive sign. From all of the interaction terms, the ones for the 1970s and 1980s are statistically significant. This significance disappears in the case of the 1970s interaction term in regression (2b), estimated using robust standard errors. More of interest is the statistical significance of the overall effect of natural resource rent per decade [7]. For this purpose, I perform a simple Wald-test for the hypothesis that the overall effect of natural resource rents per decade is statistically significant from zero. To keep the analysis concise, I will only report the results for the coefficients from regression (2b), as this can be assumed the more robust estimator of the two. For the first three decades, none of the overall effects of natural resource rents on short-run growth are statistically different from zero. The effect for the 1970s results in an χ^2-statistic of 0.04 and a significance level of 0.83, for the 1980s the results are 0.00 and 0.96 respectively. The 1990s reports a χ^2-statistic of 1.70 and a significance level of 0.19. The Wald-test for the 2000s joint significance however, shows a χ^2-statistic of 19.12, and a p-value of 0.00. This implies that the growth-enhancing effect found for the 2000s decades is statistically different from zero. The effect of natural resource rents on short-run economic growth hence appears to be stronger in the latter decade compared to the earlier ones. This effect amounts to $0.105 + 0.182 = 0.287$ percentage point, roughly the same magnitude found for effect estimated over the entire time-period from table 2.

6.2.3. Types of resources

Since it is also interesting to try to unravel whether certain types of natural resources drive growth in particular, I extend this research with a brief investigation of several different categories of natural wealth. From the World Development Indicators of the World Bank (2013), the share of natural resource rents in total income can be decomposed into several subtypes. *Coal* represents the production of hard and soft coal at world prices. *Forest* indicates the total production of wood within the country. *Minerals* includes rents stemming from tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. And finally, *oil and gas* represent the production of crude oil and natural gas combined. The different types of resources are first estimated separately in specifications (1), (2), (3), and (4). Subsequently, the different types of resources enter the equation together in specification (5). All specifications are estimated using the two-step system GMM estimator with Windmeijer-correct standard errors, and include the full set of controls and a dummy for every year. The results, test properties, and p-values for the test-statistics are shown in table 5.

Surprisingly, none of the natural resources except oil and natural gas result in a significant estimate on the short-term economic growth rate. Apparently, most of the natural resources play no role in explaining differences in economic performance. All of the different types of natural resources do yield a positive coefficient in the test results, however none of those appear to be statistically significant from zero. The effects of the rents stemming from coal, forests, and minerals all seem to be to marginal to have a significant impact on short-run growth. On the contrary, the predicted effect of hydrocarbon

[7] I.e. the combined effect of the coefficients for the natural resource rents indicator and the interaction term.

Table 5: Types of Natural Resources

System GMM Estimates of the Effect of Resource Wealth on Income Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)					
	(1)	(2)	(3)	(4)	(5)
Lagged value of log GDP per capita	0.979***	1.048***	1.038***	0.988***	1.004***
	(0.035)	(0.032)	(0.033)	(0.036)	(0.030)
Coal rents (share of GDP)	0.273				0.125
	(0.711)				(0.753)
Forest rents (share of GDP)		0.141			-0.071
		(0.473)			(0.403)
Mineral rents (share of GDP)			0.375		0.196
			(0.345)		(0.379)
Oil and gas rents (share of GDP)				0.329**	0.373**
				(0.164)	(0.177)
Full control set included?	Yes	Yes	Yes	Yes	Yes
Time dummies included?	Yes	Yes	Yes	Yes	Yes
No. of countries	122	142	142	117	117
No. of obs.	2380	2653	2653	2330	2330
No. of Instruments	79	79	79	79	97
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.698	0.187	0.176	0.849	0.778
Hansen test, P-value	0.274	0.077	0.104	0.097	0.192

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

wealth on short-term growth is substantial and significant in specification (4). On average. This effect amounts to a 0.329 percentage point increase of short-term growth, following a 1 percentage point increase in oil and gas rents. This magnitude of the coefficient approximates that of the overall natural resource rents found earlier. Both the p-values of the AR(2) and Hansen test show a value supporting the validity of this estimate. The notion that from the different types of resources, only hydrocarbons play a substantial role is confirmed in model (5). In this specification including all subcategories, none of the other natural resources has a significant effect on short-run economic growth. The coefficient for the combined production of oil and natural gas is 0.373 on average and significant at the 5 percent level. This result is interesting as some of the earlier studies report that the type of natural resource does not play a role in determining the effect on growth. Furthermore, the reported estimates seem to indicate that the positive effect of resource wealth on growth, could be largely driven by the rents stemming from oil and gas production.

6.3. Market channels

I now turn to the potential market effects of resource wealth, also known as the Dutch disease mechanisms. Section 6.3.1 focuses on the possible detrimental effects of resource abundance on manufacturing sector output, and section 6.3.2. examines the workings on relative price levels.

6.3.1. Effect on the manufacturing sector

Starting with the resource movement effect explained in section 3, I initially expect a negative impact of resource wealth on manufacturing sector output. To investigate this notion, models (1a), (2a), and (3a) are estimated using the one-step system GMM estimator. Next, A two-step system GMM estimator is employed with the Windmeijer-correction to ensure robust standard errors in models (1b), (2b), and (3b). Models (1a) and (1b) solely include the lagged values of the logarithm of manufacturing output per capita and natural resource rents as percentage of GDP. I choose for level of resource abundance in the previous period as I assume that process of transferring labour and capital resources to the natural resource sector takes some time to come about[8]. Models (2a), (2b), (3a), and (3b) include a control set to check whether other factors could play a role in explaining the output of the manufacturing sector. The controls include the growth rate of GDP per capita, openness to trade, the ratio of secondary school enrolment, gross capital formation, and population growth[9]. Due to the possibility that all of the regressors are correlated with the error term, they are entered in the GMM instrument matrix. Instrument lags 2 to 5 are used in the collapsed form to prevent instrument proliferation. Finally, models (3a) and (3b) includes time-dummies to make the assumption of uncorrelated idiosyncratic error terms across individuals more likely to hold. The results are displayed in table 6.

Model (1a) shows that a 1 percentage point higher level of resource rents at $t-1$ is followed by 0.164 percentage point lower manufacturing output in period t on average. This is in line with the resource movement effect postulated by Corden and Neary (1982). The results of (2a) indicate that the inclusion of the control set further decreases this effect to a 0.192 percentage point lower output in the manufacturing sector. When the full model including year dummies is estimated, the predicted

[8]The recruitment and selection of personnel can be considered a time-consuming process, for example.

[9]Compared to the effect on growth, life expectancy is dropped from the specification as I assume there is no relationship with manufacturing output. The growth rate is now added, since I assume that demand for manufactured goods rises as the economy grows.

Table 6: Estimation of the Resource Movement Effect

System GMM Estimates of the Effect of Resource Wealth on Manufacturing Dependent variable: Logarithm of Manufacturing Output (in 2005 U.S. Dollars)						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Log manufacturing output)$_{t-1}$	0.945***	0.961***	0.909***	0.953***	0.985***	0.911***
	(0.023)	(0.024)	(0.034)	(0.043)	(0.037)	(0.066)
(Natural resource rents)$_{t-1}$	-0.164*	-0.192**	-0.140	-0.093	-0.243*	-0.134
	(0.088)	(0.085)	(0.087)	(0.157)	(0.128)	(0.171)
Full control set included?	No	Yes	Yes	No	Yes	Yes
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	159	145	145	159	145	145
No. of obs.	3910	2497	2497	3910	2497	2497
No. of Instruments	10	35	66	10	35	66
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.263	0.673	0.763	0.353	0.682	0.711
Hansen test, P-value	-	-	-	0.116	0.222	0.139

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses. Estimated using two-step system GMM estimator with Windmeijer-correction for robust standard errors.

contraction of the manufacturing sector amounts to a 0.140 percentage point lower output. The AR(2) tests for these 3 models all report p-values which indicate that the absence of autocorrelation in the second order cannot be rejected, in favour of the instruments used. Furthermore, the estimates of the resource movement effect in models (1a) and (2a) are both significant. After the inclusion of time dummies however, the estimate is no longer significant. This indicates a lower accurateness of the estimate of model (3a) and raises doubt on the true effect of resource wealth on the output of the manufacturing sector.

The evidence for the effect of resource rents in period $t-1$ on manufacturing output per capita in period t appears to be mixed under the more efficient two-step estimator as well. In the parsimonious model (1b) the size of the manufacturing sector is on average 0.093 percentage point lower when the previous period's resource rents are increased by 1 percentage point. Holding the full set of controls constant, the negative effect is amplified to 0.243 percentage point on average, implying an even greater contraction of the manufacturing sector. When the time dummies are added to the regression, a 1 percentage point rise in resource rents at $t-1$ is associated with a 0.134 percentage point shrinkage of manufacturing output in the next year. Both the described predicted effects of model (1b) and (3b) are not statistically different from zero however, since the p-values all exceed the 10 percent confidence level. The reported evidence for the resource effect can therefore not be considered very robust. The fact that these findings cannot confirm the resource-movement effect on solid grounds can be an indication that the negative effects of resource rents do not outweigh the positive effects. If the manufacturing sector is not significantly impacted, growth stemming from that sector is not impeded either. So even though the resource-movement effect is not confirmed, the findings are compatible with the positive effect of natural resources found in section 6.1.

Table 7: Types of Natural Resources and the Resource Movement Effect

System GMM Estimates of the Effect of Resource Wealth on Manufacturing Dependent variable: Logarithm of Manufacturing Output (in 2005 U.S. Dollars)					
	(1)	(2)	(3)	(4)	(5)
(Log manufacturing output)$_{t-1}$	0.881***	0.932***	0.913***	0.850***	0.851***
	(0.089)	(0.071)	(0.081)	(0.113)	(0.087)
(Coal rents (share of GDP))$_{t-1}$	-0.199				-0.899
	(2.585)				(1.562)
(Forest rents (share of GDP))$_{t-1}$		-0.780			-0.458
		(0.624)			(0.691)
(Mineral rents (share of GDP))$_{t-1}$			0.099		-0.451
			(0.576)		(1.224)
(Oil and gas rents (share of GDP))$_{t-1}$				0.105	0.643**
				(0.427)	(0.327)
Full control set included?	Yes	Yes	Yes	Yes	Yes
Time dummies included?	Yes	Yes	Yes	Yes	Yes
No. of countries	123	145	145	117	117
No. of obs.	2189	2497	2497	2137	2137
No. of Instruments	66	66	66	66	81
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.542	0.679	0.653	0.709	0.594
Hansen test, P-value	0.135	0.203	0.139	0.019	0.094

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

Similar to the examination of the general effect on economic growth, it can also be interesting to explore the impacts on the manufacturing output when the natural resource rents are split into the different subcategories. This is done in regressions (1), (2), (3), (4), and (5) of table 7. The specification and configuration of the reported regressions are equivalent to the original regressions of table 6, except for the fact that resource rents are now divided into coal, forest, mineral, and oil and gas rents. The results of tests (1) to (4), including the different types of natural resources separately, do not yield any significant results. Contrary to the results from the combined indicator in table 6, the share of mineral rents and oil and gas rents both show a positive estimate in regressions (3) and (4) respectively. More remarkably, the predicted effect of oil and gas rents at $t-1$ in the combined regression shows a positive coefficient which is significant at the 5 percent level. Both p-values of regression (5) indicate that the instruments used are valid. All of the other types of natural resources show a negative coefficient. This difference is striking, especially since the tests for the effect on short-run growth also point towards a deviating effect for oil and gas rents. Apparently, oil and gas production impacts the economy in ways different from other types of natural wealth. Splitting natural resource rents into different subcategories therefore reinforces the suspicion that the manufacturing sector needs not necessarily be negatively impacted by natural resources. More specifically, the table shows evidence that the equipment-intensive exploration and production of oil and gas could actually boost the manufacturing sector.

6.3.2. Effect on price levels

Finally, the spending effect is tested using the one-step and two-step system GMM estimators. Similar to the resource movement effect, I start with a naive model which includes just resource rents and the lagged value of the dependent variable, after which the control set is added in specifications (2a) and (2b). Subsequently, year dummies are included in regressions (3a) and (3b). I assume prices are sticky, and it takes some time for them to adjust. For that reason, the first lag of resource rents is applied as indicator of resource abundance. Furthermore controls are added for the growth rate of income, a terms of trade index, money supply (M2), and the shares of government expenditure and public consumption to GDP. To limit the number of instruments used, I choose to include lag 2 and 3 for the price level variables. Reverse causality cannot be ruled out for the variables of GDP growth, terms of trade, and money supply, government expenditure, and public consumption. It can be the case that these factors are also partly dependent on the price levels. Therefore, the lagged values of all of the right-hand side variables are included in the GMM instrument set. To this end, lags 2 to 7 are used in the instrument matrix[10]. Finally, I regard natural resource rents to be not strictly

[10] Again the collapse function in Stata is used to prevent the instrument count from proliferation.

exogenous to the relative price level either. In the case of relatively high price levels, commodity prices are also likely to higher. This could influence the rents generated by natural resources. Therefore, the indicator is also added as a GMM instrument to the regressions, following the guidelines for endogenous variables by Roodman (2009a). The regression output of the estimated models and the test statistics can be found in table 8.

Table 8: Estimation of the Spending Effect

System GMM Estimates of the Effect of Resource Wealth on Price Levels

Dependent variable: Price Level Relative to United States Price level

	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Relative price level)$_{t-1}$	1.021***	0.999***	0.970***	1.020***	0.999***	0.971***
	(0.004)	(0.012)	(0.011)	(0.008)	(0.040)	(0.058)
(Natural resource rents)$_{t-1}$	0.084***	-0.031	-0.051	0.088**	-0.026	-0.038
	(0.024)	(0.036)	(0.041)	(0.043)	(0.050)	(0.049)
Full control set included?	No	Yes	Yes	No	Yes	Yes
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	153	141	141	153	141	141
No. of obs.	4406	2584	2584	4406	2584	2584
No. of Instruments	93	128	159	93	128	159
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.000	0.000	0.000	0.004	0.038	0.103
Hansen test, P-value	-	-	-	0.002	0.270	0.425

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses. Estimated using two-step system GMM estimator with Windmeijer-correction for robust standard errors.

Regression (1a) reports that the price levels on average are 0.084 percentage point higher if resource rents in period $t-1$ are raised with 1 percentage point. The coefficient is significant at the 1 percent level. This result is confirmed with the two-step estimator under (1b), which shows an estimated effect of 0.088. This can be regarded as some evidence for the spending effect which renders the country less appealing for the export of goods to another country. The AR(2) test reports a value which rejects the notion of no autocorrelation however, this could be an indication that the instruments used have a weak validity. It can also be the case, that the reported positive coefficient is merely representing the effects of other, omitted, factors. This could be the reason that the sign of the coefficient turns negative when the control set is added to the equation in (2a) and (2b). The magnitude of this negative effect ranges from 0.031 to 0.026 in (2a) and (2b) respectively. Furthermore, the coefficients cannot be regarded statistically significant from zero in both cases. This is a first indication that the spending effect is not prevalent in resource-rich countries. With the addition of time dummies, the effect of resource rents in period $t-1$ on relative price levels in period t is again negative. The coefficients of resource wealth in both (3a) and (3b) are -0.051 and -0.038 percentage point respectively. Both have relatively large standard errors indicating that the estimates are not very accurate. It can be drawn from these results that no robust evidence is found for the prevalence of the spending effect in resource-rich countries. Like the resource-movement effect these findings raise doubts on the effects postulated by the formal model. On the other hand, the absence of the spending effect is, like the absence of the resource movement effect, a possible explanation for the fact that a positive effect is found for natural wealth on economic growth.

The analysis of the spending effect is also applied to the different subcategories of natural resources. Table 9 shows the effects of coal, forest, mineral, and oil and gas rents at period $t-1$ on relative price levels. To prevent the number of instruments from getting too large, the models now only include instruments from period $t-2$. The results are reported under the models (1), (2), (3), and (4) for the tests of different types of resources apart from each other. Regression (5) shows the findings when the different types of resources are included simultaneously. In line with the findings of the combined natural resource indicator in table 8, the regressions do no yield any significant results for the different types of natural resources. In the case of coal and mineral, a positive effect is found, yet all of the coefficient have relatively large standard errors. Negative coefficients are found for forest rents and oil and gas rents at $t-1$, however the estimates are again not statistically significant. It should also be noted that the Hansen tests do not provide p-values which support the estimated models in any case. Parallel to the results of natural resource rents, the analysis of different types of natural resources does not yield any convincing evidence for the spending effect. The coefficient for oil and gas rents does not provide any striking results in this case, in contrary to the results for the growth rate and manufacturing output. This further strengthens the belief that the spending effect is non-existent in resource-abundant nations.

So far, I tested for the effect of resource abundance on economic growth, and the prevalence of the resource movement and spending effect on a global scale. Interestingly, the results from this section seem to indicate that resource abundance might actually have a positive effect on short-run economic growth, contradicting most of the previous work in this field. These results appear to hold when the tests are conducted with the fixed effects estimator instead of system GMM, and with the use of an alternative explanatory variable. When resources are split into different types of natural wealth,

Table 9: Types of Natural Resources and the Spending Effect

System GMM Estimates of the Effect of Resource Wealth on Price Levels Dependent variable: Price Level Relative to United States Price level					
	(1)	(2)	(3)	(4)	(5)
(Relative price level)$_{t-1}$	0.968***	0.933***	0.949***	1.034***	1.035***
	(0.078)	(0.081)	(0.069)	(0.021)	(0.022)
Coal rents (share of GDP))$_{t-1}$	1.553				1.203
	(1.400)				(1.674)
Forest rents (share of GDP))$_{t-1}$		-0.196			-0.082
		(0.355)			(0.256)
Mineral rents (share of GDP))$_{t-1}$			0.048		0.476
			(0.166)		(0.337)
Oil and gas rents (share of GDP))$_{t-1}$				-0.092	-0.048
				(0.074)	(0.079)
Full control set included?	Yes	Yes	Yes	Yes	Yes
Time dummies included?	Yes	Yes	Yes	Yes	Yes
No. of countries	117	141	141	113	112
No. of obs.	2174	2584	2584	2112	2110
No. of Instruments	101	101	101	101	107
AR (1) test, P-value	0.002	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.145	0.103	0.110	0.000	0.001
Hansen test, P-value	0.027	0.007	0.003	0.033	0.040

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

interestingly it appears that the positive effect is mainly driven by oil and gas rents. Furthermore, the analysis on time periods indicates that the growth-enhancing effect is particularly apparent in the first decade of the new millennium. Some very weak evidence is found for the resource movement effect, which can be interpreted as a contraction of the manufacturing sector. However, a smaller manufacturing sector does not necessarily need to result in a lower growth rate in the short run, as becomes clear from the results. Moreover, the results also indicate that oil and gas rents might actually have a positive effect on the output of the manufacturing sector. Evidence for the potentially harmful spending effect appears to be inconclusive as the results are ambiguous and insignificant. This is also the case when the natural resource rents are split into the subcategories. To further check the direct effect of resource wealth on economic growth and the two market channels, the empirical framework is adopted to the United States in the next section. This part will form an extension to the main research of this paper.

7. Regional evidence in the United States

To check whether the results found in section 6 are not caused by factors arising from differences in data measurement and unobserved characteristics across countries, I now turn to the analysis of the 50 United States for the period 1987-2012. On this regional scale, these confounding factors are assumed to be smaller, as various growth influencing characteristics, like institutional quality and technological progress, can be considered roughly constant across the United States.

7.1. Natural resources in the U.S.

The 50 states composing the United States of America provide a suitable topic for conducting a within-country study. According to the Central Intelligence Agency (2013) *World Factbook*, the U.S. produces a wide array of natural resources including gold, iron, silver, timber, and rare earth elements amongst others. The largest production values are recorded in the crude oil, natural gas, and coal sectors. In 2013, the U.S. held the world's largest amount of coal reserves amounting to 491 billion short tons, which is the equivalent of 27 percent of the world's total (Central Intelligence Agency, 2013). Nevertheless, the biggest boom of the recent years is experienced in the oil and gas sector, in particular the market for *unconventionals*. Unconventionals can be defined as oil and gas products which are produced or extracted using other techniques than conventional methods. Probably the best-known examples are *shale oil and gas* and *oil sands* extracted from shale rock formations and sandstones respectively. With the development of new extraction techniques, it recently became feasible to extract hydrocarbons from these otherwise unreachable sources, leading to significant increases in production.

In the U.S., the shale oil and gas boom concentrates primarily around three large shale oil formations. These formations include *Bakken* in North Dakota, the *Permian Basin* which spans Texas and New Mexico, and *Eagle Ford* also in Texas. In the Northern U.S. based *Bakken* formation, oil was already discovered in 1951. It was only in the 2000s however, with the discovery of hydraulic fracturing and horizontal drilling technologies, that production dramatically increased. The same applies to the other formations of shale oil and gas, together leading to a boom in U.S. hydrocarbon production. Besides possibly altering the world political position of the U.S. as a whole in the future, the Dutch disease model by Corden and Neary (1982) predicts shale state economies to be potentially impacted as well. For that reason, the heterogeneity in natural resource abundance across U.S. states, which in part is the result of the strong increase of hydrocarbon production, provides an interesting topic to study potential Dutch disease effects on a regional scale. To that end, the same empirical framework in the first part of this paper is applied on the 50 states forming the United States.

7.2. U.S. data and descriptives

The majority of state-level data is collected from the U.S. Bureau of Economic Analysis (2014). From their database, state-level GDP data in real terms is collected and subsequently divided by state-specific population levels, resulting in a measure of income per capita (*gdps*). Similar to the global dataset, output data on a sector level is available from the Bureau of Economic Analysis. This allows the examination of possible resource effects on the size of the manufacturing sector directly. The level of manufacturing output in real terms (*gdpm*) is calculated in the same was as for the global dataset. Unfortunately, relative price levels and real exchange rates are unavailable on the state level. The best available alternative is most likely to compare price levels directly across states. These price levels are available in the form of consumer price indices (CPI). This data is not available on state level however. Instead, data is available for four large regions in the U.S. and for selected cities. As a solution, state price levels are proxied by extracting the city-level CPI data and allocating this to the state in which the corresponding city is located. States for which cities are missing are allocated using the data from the regional level. This methodology can be considered as very arbitrary and as a consequence, the results should be interpreted with extreme caution. The main focus of the regional test will therefore lie on the general effect on growth and on the resource movement effect. Still, the proxies constructed are the closest data available approximations for comparing relative prices on the state level.

On the U.S. State level, resource abundance is measured as per capita production of the natural resource sector, (*natres*). This level is composed of the output levels of two sub-sectors in the total economy. First of all, sector 11 from the North American Industry Classification (NAICS) system, which consists of: agriculture, forestry, fishing, and hunting. The second part consists of the mining sector, NAICS code 21. Sector-level output is collected from the U.S. Bureau of Economic Analysis (2014). Unfortunately, the database of the Bureau of Economic Analysis does not allow the disentanglement of agriculture rents from the aggregate natural resource indicator. Agriculture is not included in the world dataset indicator, which undermines the comparability slightly. Still, the U.S. indicator of choice is the only one available in time-series, and therefore the most adequate for this research.

Control variables for the analysis on a regional level are selected analogously to the global dataset. As gross capital formation data is not available on state-level, investment is proxied using the total level of per capita machinery manufacturing (*invp*), NAICS code 333. This variable is again collected from the U.S. Bureau of Economic Analysis (2014). As this entails the production of durable non-financial assets used for the production of goods or services, a higher level of machinery manufacturing can be interpreted as a higher level of capital investment. Since no sound time-series on educational enrolment are available to my knowledge, I use total per capita production in education services (*edup*) as a proxy for the level of human capital in each state. This is in line with Papyrakis and Gerlagh (2007) in their study on the effects of resource wealth in the U.S. states. This variable is also obtained from the U.S. Bureau of Economic Analysis (2014), and can be found under NAICS code 61. The total level of Research and Development (*rnd*) is also included as control variable. This indicator, measured as percentage of total GDP, is collected from the National Science Foundation (2014). As innovation is generally regarded to amplify economic growth, this control is expected to have a positive effect in the regression model. Population growth levels (*popgr*) are taken from the U.S. Census Bureau (2014). Finally, data on state government debt (*dbt*) and expenditures (*gxp*) are collected from the U.S. Census Bureau (2014).

The descriptive statistics for the U.S. dataset are presented in table 10. Along the lines of the global dataset, states are considered resource-poor when less then 8 percent of their income stems from the natural resource sector, and resource-abundant otherwise. As is shown in the table, GDP per capita is slightly higher in the states which produce relatively low amounts of natural resources. On the other hand, manufacturing output appears to be lower in the resource-abundant states. This is in line with the expected resource movement effect, all tough the difference is not substantial. Relative price levels, measured by the consumer price index, are also lower on average in the resource-abundant states. The latter contradicts the expected spending effect. Interestingly, the logarithm of state GDP seems to be slightly higher in the resource-poor states, although no conclusion with respect to the short-run growth rate can be drawn from these values.

Table 10: Summary Statistics U.S. Dataset 1987-2012

	U.S.		**Res. Poor**		**Res. Abundant**	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Log GDP per capita	10.414	0.279	10.418	0.264	10.398	0.340
Log manufacturing output per capita	8.305	0.499	8.381	0.463	7.956	0.510
Relative price level	1.711	0.348	1.729	0.352	1.628	0.320
Natural resource rents (% of GDP)	0.047	0.067	0.023	0.018	0.161	0.090

Notes: All data is collected from the U.S. Bureau of Economic Analysis. R&D expenditure data is from the U.S. National Science Foundation.

7.3. Results for the U.S. dataset

Results are reported for the resource curse thesis in section 7.3.1, followed by the resource movement and spending effect in sections 7.3.2 and 7.3.3 respectively. The set-up used is similar to the one for the global dataset. The results of the control variables and time dummies are omitted from the tables to concentrate on the effects of interest in this study. Complete results can be found in appendix D.

7.3.1. The resource curse thesis in the U.S.

First, regressions are estimated using one-step system GMM estimator. Next, two-step system GMM with robust standard errors is applied to check the robustness of the configuration of the GMM estimator. Models (1a) and (1b) focus on the effect of resource rents solely. In (2a) and (2b) the control variables are included, and in (3a) and (3b) time dummies are added to the equation. The number of countries, observations, and instruments are reported at the bottom of the table, as are the p-values for the autocorrelation and Hansen test statistics. The other covariates which are applied in the regressions (2a), (2b), (3a), and (3) include the first lag of natural resource rents in logarithmic terms, investment in machinery, government expenditure, R&D expenditure, and population growth. For all of these regressors it cannot be ruled out that they are also influenced by the level of income per capita. This implies that it is not unlikely that the explanatory variables are correlated with the idiosyncratic error term. For that reason, all of the controls are inserted as GMM instruments in the regressions. This means that lagged values of the regressors are applied as instruments for the potentially endogenous variables[11]. Several factors which are generally thought of to augment economic growth, and which were included in the global dataset, are left out of the regressions as they can be assumed to be very much homogeneous across the United States. The quality of institutions is not likely to differ significantly across states for example. The estimation results of the resource curse thesis applied to a regional scale are presented in table 11.

Regression (1a) shows that on average, an increase in production rents from the natural resource sector by 1 percentage point, will lead to an increase in the short-run growth rate of 0.487 percentage point. This effect is substantially increased to a value of 0.771 percentage point, when the set of control variables is held constant in regression (2a). Furthermore, the predicted estimate is now significant at the 10 percent level, and the p-value of the AR(2) test is also more robust. In the last regression dummies are added for each time period[12]. The resulting coefficient for natural resource rents now amounts to a 0.560 percentage point higher growth rate. The estimate is now also significant at the

[11] Similar to the global dataset, lags 2 to 6 are employed as instruments in models (1a), (2a), (3a), (1b), (2b), and (3b), to prevent that the number of instruments exceeds the number of states.

[12] As reverse causality is highly unlikely for these time dummies, they enter the GMM estimation as regular external instruments.

Table 11: Regional Evidence of the Resource Curse

System GMM Estimates of the Effect of Resource Wealth on Income Dependent variable: Log of Real State Income per Capita						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Lagged value of log GDP per capita	1.001***	0.993***	0.853***	1.001***	0.994***	0.861***
	(0.003)	(0.008)	(0.101)	(0.002)	(0.004)	(0.089)
Natural resource rents (share of GDP)	0.487	0.771*	0.560***	0.404	0.807***	0.569***
	(0.555)	(0.463)	(0.206)	(0.309)	(0.298)	(0.217)
Full control set included?	No	Yes	Yes	No	Yes	Yes
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	50	50	50	50	50	50
No. of obs.	1250	699	699	1250	699	699
No. of Instruments	12	36	50	12	36	50
AR (1) test, P-value	0.000	0.003	0.000	0.000	0.000	0.001
AR (2) test, P-value	0.085	0.428	0.970	0.011	0.230	0.980
Hansen test, P-value	-	-	-	0.000	0.057	0.196

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

1 percent level. These results from the one-step estimator indicate that also in the United States, natural resource rents could have a contribution to short-run growth. This confirms the results found in the first part of this study.

Employing the asymptotically more efficient two-step estimator, a similar pattern is found. The estimate of the naive model now indicates a 0.404 percentage point higher short-run growth rate, for a 1 percentage point higher level of resource rents. When the full set of covariates and the time dummies are added, the predicted effects amount to 0.807 and 0.569 percentage point respectively. These results, reported under (2b) and (3b), show p-values for the AR(2) and Hansen test which indicate validity of the tests employed. Both coefficients are highly significant, adding support to the hypothesis that resource wealth can provide the fuel for economic growth. This further strengthens the findings reported in the test on the world scale. Compared to those findings, the reported coefficients appear to be slightly higher in magnitude. This can be an indication that the U.S. is better able to manage the extraction, production and marketing of their natural resource endowments, compared to the global average. Together, the results from the global and regional scale, show promising evidence for a positive effect on short-run growth. It should be noted however, that despite this notion, these results cannot be extrapolated one-to-one to other countries. This is the case, as the U.S. is a very distinct country with it's own specific environment of legal, political, economic, and technological characteristics. All of which could influence the effect natural resources have on the domestic economy.

7.4. Market channels in the U.S.

7.4.1. Effect on the U.S. manufacturing sectors

To examine the potential detrimental effect on the manufacturing sector further, the resource movement effect is also investigated at the regional level of the United States. Again, I assume that the process of shifting labour and capital from one sector to another is a lengthy one. Therefore, the share of state GDP originating from natural resources for the period $t-1$ is adopted as the main regressor of interest. The lagged value of manufacturing output per capita in logarithmic terms is included to control for potential convergence effects in the manufacturing sector. In models (2a), (2b), (3a), and (3b) further controls are added for the growth rate of the economy, investment in machinery, educational spending, R&D spending, and population growth. With the exception of educational spending, all of the regressors are considered potentially endogenous. The latter are therefore instrumented using GMM style instruments. It is recommended by Roodman (2009a) that all variables, including the exogenous ones, are entered as instruments in some form. Since I suspect that the level of educational spending is not influenced by the size of the manufacturing sector, this variable is entered as an IV style instrument. The regression results are displayed in table 12. P-values of the test statistics and sample properties can be found at the bottom of the table.

Regressions (1a) and (1b), which only include the lagged level of natural resource rents, surprisingly show a positive relation between resource rents at $t-1$ and the growth rate of the manufacturing sector in period t. In regression (1a) a 1 percentage point higher level of resource rents at $t-1$ is associated with a 0.466 percentage point higher growth rate. In (1b) this effect is slightly smaller at 0.331 percentage point. Both models however report relatively large standard errors, indicating that the estimates are not very accurate. The Hansen p-value of model (1b) also shows that the instruments used in this regression are likely not valid. Hence, the reliability of these results is not very high. When a full model of covariates is applied in (2a) and (2b), the sign of the estimate changes to negative. The predicted effects now amount to -0.574 percentage point slower growth on average when estimated with the one-step estimator, and a -0.619 percentage point decrease in the case of two-step estimation, holding all other covariates equal. The inclusion also increases the validity of the results as can be seen by the Hansen statistic p-values. The standard errors remain relatively large however with values of 0.434 and 0.948 respectively. The estimates of (2a) and (2b) are therefore not statistically different from zero. Regression (3a) shows that with the addition of times dummies

Table 12: Estimation of Regional Market Mechanisms

System GMM Estimates of the Effect of Resource Wealth on Manufacturing Dependent variable: Logarithm of Real Manufacturing Output						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Log manufacturing output)$_{t-1}$	0.995***	1.009***	0.870***	0.997***	1.002***	0.894***
	(0.005)	(0.014)	(0.098)	(0.006)	(0.020)	(0.100)
(Natural resource rents)$_{t-1}$	0.466	-0.574	-0.597*	0.331	-0.619	-0.564
	(0.411)	(0.434)	(0.325)	(0.226)	(0.948)	(0.582)
Full control set included?	No	Yes	Yes	No	Yes	Yes
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	50	50	50	50	50	50
No. of obs.	1250	738	738	1250	738	738
No. of Instruments	8	25	40	8	25	40
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.002	0.010
AR (2) test, P-value	0.827	0.415	0.950	0.890	0.438	0.805
Hansen test, P-value	-	-	-	0.000	0.157	0.268

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

the coefficient is slightly amplified, now indicating a 0.597 percentage point lower growth rate. The predicted effect is now also statistically significant at the 10 percent level. When the same regression is estimated with the two-step estimator, the effect is roughly equal at -0.564 percentage point, yet the estimate is no longer significant. The p-value of the Hansen test in regression (3b) is also relatively high at 0.268[13]. Hence, no strong support is found for the contraction of manufacturing output as a result of natural resource abundance, which is in line with the results from the global dataset. Again this could be an explanation why the economy growth rate is not negatively impacted by natural resource rents.

[13] According to Roodman (2009a), p-values of 0.25 or higher could be an indication of an overfit of the endogenous variables, and a weakened Hansen test.

7.4.2. Effects on state price levels

Finally the spending effect is examined on a regional scale to exclude any potentially noise-creating influences which differ across countries. The baseline of the estimated models is similar to the one used on a global scale, with one lagged value of the price level and resource rents. The control set for this regional analysis includes the annual growth rate of per capita GDP, state government expenditure, and state debt. For the price levels, the 3rd up to the 5th lags are used as GMM instruments, as I assume the error term of the second lag to be potentially correlated with the idiosyncratic error term of the level specification, due to the autoregressive nature of the process. For the other covariates, the lags 2 to 6 are employed. Resource rents are also added as GMM instruments, as I assume that the rate of extraction could be in part determined by the expected market prices of commodities. The output of the one-step and two-step estimations is represented in table 13.

Table 13: Estimation of the Spending Effect on a Regional Scale

System GMM Estimates of the Effect of Resource Wealth on Price Levels

Dependent variable: Consumer Price Index

	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Consumer price index)$_{t-1}$	1.025***	1.023***	1.074***	1.014***	1.021***	1.043***
	0.000	(0.006)	(0.012)	(0.003)	(0.003)	(0.021)
(Natural resource rents)$_{t-1}$	0.024***	0.005	0.017*	0.450***	0.082*	-0.002
	(0.008)	(0.010)	(0.009)	(0.173)	(0.049)	(0.026)
Full control set included?	No	Yes	Yes	No	Yes	Yes
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	50	50	50	50	50	50
No. of obs.	1250	1051	1051	1250	1051	1051
No. of Instruments	5	23	45	10	28	50
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.000	0.550	0.886	0.000	0.248	0.739
Hansen test, P-value	-	-	-	0.000	0.001	0.060

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

The table shows that in naive regression (1a), the consumer price index appears to be higher on average when the resource rents at $t-1$ are increased. This result is statistically significant at the 1 percent level. The predicted effect diminishes almost entirely but still remains slightly positive with the inclusion of the control set in (2a). The statistical significance however is now no longer prevalent. The results of regression (3a) including the time dummies again show a positive effect of natural resource rents at $t-1$ on the consumer price index in period t. The predicted coefficient equals 0.017 percentage point. Furthermore, the p-value of the AR(2) test is larger than the 10 percent level indicating that the no autocorrelation hypothesis of the second order in differences cannot be rejected. This is in favour of the validity of the applied instruments. This can be interpreted as some support for the spending effect, although the evidence is at most very weak.

Regression (1b) reports a relatively large positive coefficient of 0.450 between resource rents in the previous period and the consumer price level in the current period. The estimate appears to be significant at the 1 percent level, yet the Hansen test reports a p-value of 0.000. This is an indication that the model is overfitted, the estimate cannot be considered reliable for that reason. This is also the case for the coefficient reported when specification (2b) is tested. The estimated effect is still positive however, in line with the spending effect hypothesis. In regression (3b) including the full control set and time dummies, the effect almost entirely diminishes to -0.002. According to the reported p-value of the Hansen test, model (3b) employs valid instruments. However, the effect is not statistically significant. Together, the findings of the potential spending effect on a regional scale prove to be inconclusive. No robust evidence is found for a positive effect of resource rents on the consumer price index. These results acknowledge the absence of empirical evidence which was reported on a global scale. Although the validity of these results are highly questionable due to the arbitrary construction of the price level proxy.

In addition to the analysis on a world scale, I now tested for the economic effects of natural resources on the regional level using the system GMM framework. I started with the effect on short-run economic growth followed by the resource movement and spending effects. The regression output shows that the results regarding the impact on growth from the global level are confirmed for the 50 United States, albeit the magnitude of the effect is slightly increased. Evidence for the resource movement and spending effect are at most very weak, based on the tests of this United States dataset. This is also in line with the results reported for the global dataset, all tough the evidence for the resource movement effect was stronger on a world scale. All of the results stemming from both datasets will be discussed in the following section.

8. Discussion

This section aims to provide interpretation to the results found in this research. First the results of the resource curse will be discussed, followed by the resource movement and spending effect. Next, a comparison is made between the analysis of resource abundance on a global scale versus an analysis on a regional scale. Finally, light is shed on the limitations of this research.

8.1. The resource curse thesis

The findings of this empirical study on the effects of natural resource wealth on economic growth, remarkably provide evidence that the resource curse could have shifted towards a resource blessing. This evidence appears to be fairly robust. In the analysis of the global dataset, a significant positive effect is found in six out of the six tested regression models. Even with the correction for robust standard errors applied, the predicted coefficient remains positive and statistically significant. Further support for a resource blessing is provided by the robustness tests. The fixed-effect estimator confirms that the positive effects are not likely to be driven by the choice of estimator. The result is also robust to the use of an alternative measure of resource abundance, the share of primary exports to GDP. This indicator is used in the majority of prior research which report evidence for a negative effect of natural resources. Finally, when the empirical framework is applied to the 50 United States, the positive effect of natural resource rents on economic growth is again confirmed. Four out of the six estimated models yield a statistically significant positive effect of resource wealth on short-run growth, adding further support to the main findings of this paper.

Strikingly, the results reject hypothesis I and thereby undermine the original evidence of the resource curse found by much of the influential studies on the effects of natural resource wealth. The findings of these earlier studies therefore prove not to be entirely robust to changing the he econometric framework from cross-sectional growth regressions, to a more advanced dynamic panel-data analysis. It could be the case that a single cross-country set-up is not adequate enough to estimate the true effects due to a bias that arises from correlation between the explanatory variables and unobserved country characteristics. The latter is unavoidable in dynamic growth regressions, violating the assumption of strict exogeneity and leading to biased coefficients.

An alternative explanation could also play a role in these findings. The results of the analysis on time periods indicate that the effect of natural resource rents on short-run growth differs across decades. In particular the effect appears to be negative for the 1980s and positive for the 2000s. Ross (2012) points out that most of the seminal research adopts a sample period ranging from 1970 to 1990. Within this period many of the resource-rich economies consisted of oil-exporting countries. During the 1970s the oil price increased greatly after the 1973 oil crisis which was fuelled by the OPEC embargo, followed by the energy crisis of 1979. During these times, oil-exporting countries faced difficulties in managing their natural resources. The peak in oil prices was followed by a fall when oil consumption was cut back globally during the 1980s. This led to a subsequent drop in the income levels of these countries (Ross, 2012). Moreover, many oil exporting countries, used their natural wealth as collateral for substantial amounts of foreign debt. When the price of oil plunged, the natural resource assets underlying this debt decreased in value leading to economic struggles for resource-rich countries (Manzano and Rigobon, 2001). This could be an explanation for the fact that a large part of the studies on resource wealth report a paradoxical negative relation between resources and economic growth. As can be seen from figure 4 in appendix E, the oil prices remained relatively steady after the 1980s, and started rising significantly during the 2000s. A similar pattern can be identified for other natural resource commodities, fuelled by growing global demand. This is illustrated in figure 5 of appendix E. As this study adopts a timespan from 1980 to 2011, this could be an explanation for the positive relationship reported by the estimations.

The relevance of the main findings in this paper to policy-makers today, is that they shed new light on countries endowed with natural resources. Some support is provided for the notion that the future for such countries could actually be brighter than one would expect, based on earlier work in this field. More studies confirming this result could alter the way economic policy is shaped in resource-rich countries. If the effect of natural resource wealth on short-run economic growth is indeed positive, natural resource-based activities should perhaps play a more central role in a domestic economy. World development organisations could focus more on stimulating resource-based growth strategies in poor countries. This could provide the opening for such less-developed countries, often endowed with substantial amounts of resource wealth, to achieve higher rates of growth of the domestic economy.

8.2. Market channels

At first glance, the results of the global dataset indicate a negative association between resource rents and the size of the manufacturing sector. This is in line with the resource movement effect of Corden and Neary (1982) and with hypothesis II. The accuracy of the results is worrisome however, as only 2 of the 6 models report coefficients which are statistically significant. Similar mixed results are found when the statistical tests are conducted on the United States level. Therefore evidence for the resource movement effect cannot be considered convincing, leading to the rejection of hypothesis II. This raises doubt on the theory that resource wealth has a detrimental effect on the output of manufacturing, through which it ultimately might deteriorate the growth path of an economy. It could be the case that the manufacturing industry is not harmed by a large resource producing sector. One explanation could be that the natural resource companies spur manufacturing companies in the region, supplying the technologically advanced equipment needed to extract, produce, and refine the natural products. These potentially regional clustering effects could compensate the possible loss in manufacturing factor endowments in resource-rich economies. The findings of the tests of the resource movement effect for different types of natural resources provide some support to this possible explanation. These results indicate that oil and gas wealth have a positive impact on manufacturing output, in contrary to the other types of resources. This industry can be considered highly dependent on a wide array of equipment an components supplied by the manufacturing sector[14]. This could be the reason that a positive effect is found between the rents of hydrocarbons and the growth of the manufacturing sector, and for the absence of evidence on the resource-movement effect in general. Alternatively the explanation could lie in the international factor mobility which characterises the natural resource industry. Natural resource producing companies, like oil companies, generally employ high-skilled workers. It is not uncommon for these companies to send their engineers abroad to work on specific natural resource producing projects. A large part of the labour force in for example the iron or petroleum industry therefore consists of expatriates working around the world. International labour mobility in these industries can be assumed relatively high. Therefore, a vast deposit of natural wealth does not necessarily need to lead to a shrinkage of other sectors, as long as the factor endowments are imported from abroad. This is not considered in the original theory by Corden and Neary (1982).

Evidence for the spending effect, and thus hypothesis III, remains largely inconclusive. This applies for both the global as the regional dataset. The predicted effects are not robust to small changes in the econometric framework, resulting in both positive and negative signs. Furthermore, the magnitude of the estimated effects is marginal in all cases. One problem that arises from my empirical framework is the indicator of non-traded price levels. As this measure is unavailable, I rely on the use of aggregate price levels relative to the United States price level. This is at best an approximation of the true effect of interest and could be the reason of unreliable estimates. This potential pitfall is even larger for the United States dataset, as price levels are not widely available for the 50 states. The constructed measure is an arbitrary one since state price levels might deviate from the city-region price levels from which they are derived in this case. Therefore the results of the United States dataset should be interpreted with extreme caution. Further explanations for the inconclusive results could lie in the econometric specification of the regressions which are employed. It is generally accepted that price levels are extremely complex to model in an empirical framework, as the processes are to a great extent autoregressive with potential shocks occurring from time to time. The specifications I use, may simply be not sophisticated enough to realistically model the evolution of price levels. Moreover, the formal model which acts as the baseline for my empirical framework, considers a small-open economy. The latter is a simplified version of the real world. Therefore, the effects hypothesized by this model need not necessarily be true compared to the real-world dynamics of a resource-rich economy. Altogether, the results of both datasets lead to the conclusion that no convincing evidence is found for the spending effect. This leads to the conclusion that hypothesis III is also rejected. While the lack of support for both Dutch disease effects is somewhat unsatisfactory, it is coherent with the positive effects of natural resource rents on short-run economic growth which

[14]Examples include pipelines, drilling wells, LNG carriers, and large refinery facilities amongst others.

are reported in this study. If the manufacturing sector does not contract, and at the same time price levels do not increase dramatically, the competitiveness of the country remains unharmed. This could be an explanation why the short-run growth path of a country does not appear to be impacted by the production of natural resources.

8.3. Limitations of the study

Several shortcomings arise from the choices I have made in this research. Besides the ones I have already elaborated upon, one shortcomings lies in the dynamic panel-data model which is also the main innovation of this paper. The Arellano-Bover/Blundell-Bond estimator is subject to configuration choices based on assumptions by the researcher[15]. Minor changes in these assumptions bear the risk of overfitting the model, leading to unreliable estimates. To counter the potential adverse effects of a wrongly configured estimator, I tested every result using the one-step and two-step estimators, which differ in their set-up. A further shortcoming could be that the specific estimator is particularly designed for small T large N datasets. The adopted sample consisting of 31 periods is relatively high, however at least one study points out that the system GMM estimator is still consistent in large T panels (Hayakawa, 2006). Moreover, the results also appear to hold when the framework is tested using the fixed effects estimator, which is not designed specifically for small time periods. A solution could be to divide the sample period in smaller time spans, for example 5-year intervals. This way the number of time periods can be reduced, which could lead to a better fit of the system GMM model. Still, the superior performance of the system GMM estimator for me is the reason to justify its application in the main specifications tested in this study.

Second, several limitations are attached to the adopted indicator of resource wealth, natural resource rents. First of all this indicator could suffer from bias spurred by reverse causality, as is the case with most of the variables in growth regressions. It cannot be fully ruled out that much of these variables suffer from endogeneity. It could be the case for example that countries which are more developed have better technical and institutional possibilities to extract and produce natural resources in an economically feasible way. This reverse causality could also apply to the measurement of resources, as it is a sophisticated process to approximate the amount of natural resources in the ground. Furthermore, the explanatory variable is measured as the share of rents to GDP, a construction which could also lead to endogeneity. The magnitude of total GDP in the denominator is dependent on the resource rents as well. Stock variables in the form of estimated resource deposit values could mitigate this issue, however these are simply not widely available. Due to the availability, I therefore chose to adopt resource rents as measure of resource wealth. A further shortcoming to the indicator could be

[15]This estimator can be manually programmed in the statistical software package *Stata* with the *xtabond2* command.

the fact that much of the missing data is reported for the already underdeveloped nations, which could influence the results as well. Lastly, it could also be the case that resource based effects could depend on the type of natural resources. The extension in this study covering the tests for different types of natural resources shed some additional light on this topic. According to these results, the positive effect is largely driven by oil and gas rents. One interpretation lies in the pivotal role hydrocarbons play in the global economy. A more worrisome interpretation could be that these findings are the result of reverse causality. It is not uncommon that the demand for oil rises as the economy grows for example. For this reason, exogeneity of the oil and gas indicator as regressor, cannot be fully ruled out.

Future research could be aimed at further developing the use of dynamic panel-data models in this field. Especially, different sample periods or regions could provide interesting research topics as the results seem to depend to some extent on these changes in these factors. In addition, subsequent studies adopting a dynamic panel-data approach could focus on the potential political and institutional effects of resource wealth. To my knowledge, these mechanisms have not been studied extensively yet, using the more sophisticated approach of panel-data. The very distinct effects for oil and gas rents compared to other natural resources found in this study, also provide an interesting topic for future research. It could be the case that the natural resource curse, or blessing, is actually a phenomenon of oil and gas wealth. While this study gives some insight into this matter, more research is obviously needed to confirm these results. One of the biggest gains however, could be made when stock data on natural resources becomes more widely available. As this measure is independent of the income level of a country, measurement problems aside, the estimates will be a better approximation of the true causal effect of resource wealth on the economy.

9. Conclusion

This study provides a re-examination of the relationship between natural resource abundance and economic performance. In an attempt to address the issues that arise from the use of single cross-country growth regressions, two new dynamic panel-datasets are constructed for this analysis. These datasets are tested using a system GMM approach, which exploits internal instruments in the form of lagged values to filter out the exogenous effect of the explanatory variables. The results of this study show that the natural resource wealth could actually have a positive effect on the short-run economic growth of a country. The findings are supported both on a global scale and the regional scale of the United States. The results are able to withstand several tests of robustness, providing further support for the effect of natural resources reported in the paper. On the contrary, evidence for the two hypotheses covering the potential market mechanisms is less determinate. Both the estimates for the resource movement effect and estimates for the spending effect prove to be inconclusive. While this undermines the formal Dutch disease model adopted in this study, the absence of both market effects does grant support to positive effect of resource wealth. The main findings shed new light on the resource curse discussion which has captivated economists over the past few decades. The importance of the main finding of this paper lies in the new insights it creates on the impact of resource wealth on the domestic economy of a country. Where the majority of the early work indicates that the consequences of resources are mainly detrimental economic development, this study indicates that natural capital could possibly aid the growth of the country's gross domestic product. It should be stated however, that the issue of reverse causality cannot be ruled out in these results. As this is one of the first studies to report a potential positive impact of resource abundance on growth, policy makers should interpret the results with caution. Before any sound policy advice can be formulated, extra research is needed to confirm the effects found in this paper. If these findings are confirmed by future research, it could alter the prospects of countries endowed with significant deposits of natural resources.

The question what causes the different findings in the results, remains question of debate. While some attention is given to this question in this paper, the findings are at most first steps towards that direction. These exploratory steps indicate that besides from the changes in econometric framework, the negative results could also be driven by the choice of sample period. The last decade, in particular appears to have a strong growth-enhancing effect, compared to its predecessors. It are precisely those earlier decades, which are the sample period of choice in most the influential papers which report evidence for a negative effect of natural resources. To confirm this reading, more evidence is certainly warranted on the topic. Revisiting the effect remains an important goal as it could very much alter the future prospects of countries endowed with a wealth of natural resources. The more sophisticated techniques which are available today, provide the means necessary for a more unbiased and efficient identification. These improved econometric techniques should therefore be the way forward in the field of empirical growth studies, as the questions what makes some countries rich and other countries poor remains important in the years to come. If the effect of natural resource wealth on short-run economic growth is indeed positive, the opportunity could be there for under-developed resource-abundant nations, to find a definitive way out of poverty.

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A. Descriptive statistics

Table 14: Summary Statistics World Dataset 1980-2011

	World		**Res. poor**		**Res. abundant**	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent						
Log GDP per capita	7.858	1.629	8.178	1.617	7.332	1.510
Log manufacturing output	1.205	0.686	1.395	0.685	0.883	0.556
Relative price level	0.547	0.315	0.580	0.338	0.492	0.263
Explanatory						
Natural resource rents (% of GDP)	0.095	0.104	0.023	0.021	0.241	0.166
Controls						
Gross capital formation (% of GDP)	0.226	0.086	0.222	0.074	0.232	0.103
Openness to trade	0.781	0.519	0.804	0.563	0.732	0.402
Institutional quality proxy	0.019	0.072	0.044	0.065	-0.019	0.065
Ratio of sec. education enrolment	0.667	0.331	0.728	0.320	0.556	0.320
Population growth (%)	1.114	0.368	0.014	0.013	0.023	0.018
Life expectancy (years)	65.534	10.473	68.306	9.636	61.638	10.364
GDP growth (%)	0.017	0.064	0.018	0.056	0.015	0.076
Net barter terms of trade index	1.114	0.368	1.032	0.261	1.243	0.463
M2 (% of GDP)	0.516	0.485	0.600	0.565	0.379	0.257
Govt. expenditure (annual % growth)	0.823	0.039	0.034	0.107	0.050	0.202
Consumption expenditure (% of GDP)	0.823	0.823	0.845	0.144	0.786	0.188

Notes: All data is collected from the World Bank's *World Development Indicators 2013*. Relative price levels are collected from...

Table 15: Summary Statistics U.S. Dataset 1987-2012

	U.S.		**Res. Poor**		**Res. Abundant**	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent						
Log GDP per capita	10.414	0.279	10.418	0.264	10.398	0.340
Log manufacturing output per capita	8.305	0.499	8.381	0.463	7.956	0.510
Consumer price index	1.711	0.348	1.729	0.352	1.628	0.320
Explanatory						
Natural resource rents (% of GDP)	0.047	0.067	0.023	0.018	0.161	0.090
Controls						
Machinery investment (% of GDP)	0.011	0.009	0.011	0.009	0.008	0.009
State expenditure (% of GDP)	0.198	0.338	0.195	0.334	0.215	0.354
Education investment (% of GDP)	0.008	0.005	0.009	0.005	0.004	0.002
R&D expenditure (% of GDP)	0.022	0.016	0.022	0.014	0.017	0.023
Population growth (%)	1.025	1.082	1.061	1.086	0.859	1.050
Growth rate (%)	0.021	0.044	0.021	0.042	0.024	0.050
State debt (% of GDP)	0.071	0.041	0.071	0.041	0.073	0.037

Notes: All data is collected from the U.S. Bureau of Economic Analysis. R&D expenditure data is from the U.S. National Science Foundation.

B. Regression output global dataset

Table 16: Estimation of the Resource Curse

System GMM Estimates of the Effect of Resource Wealth on Income Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Lagged value of log GDP per capita	0.986***	1.052***	1.034***	0.993***	1.030***	1.014***
	(0.008)	(0.010)	(0.011)	(0.015)	(0.025)	(0.030)
Natural resource rents (share of GDP)	0.291***	0.434***	0.366***	0.280***	0.326***	0.297**
	(0.043)	(0.042)	(0.040)	(0.103)	(0.118)	(0.124)
Gross capital formation (% of GDP)	0.360***	0.442***	0.405***	0.328***	0.402***	0.420***
	(0.035)	(0.036)	(0.038)	(0.115)	(0.102)	(0.119)
Openness to trade	0.059***	0.01	0.038**	0.046	0.021	0.047
	(0.016)	(0.019)	(0.019)	(0.035)	(0.046)	(0.056)
Institutional quality proxy	0.227***	0.031	0.213**	0.045	-0.112	0.084
	(0.078)	(0.087)	(0.104)	(0.236)	(0.217)	(0.229)
Ratio of sec. education enrolment	0.156***	-0.287***	-0.264***	0.043	-0.199*	-0.17
	(0.035)	(0.039)	(0.040)	(0.096)	(0.102)	(0.108)
Population growth (%)	-0.944***	-1.593***	-1.484***	-1.242***	-1.461**	-1.494**
	(0.309)	(0.325)	(0.317)	(0.417)	(0.705)	(0.621)
Life expectancy (years)	-0.001*	0.003***	0.004***	-0.001	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
*Nat. resources * Institutional quality*			-2.211***			-1.991
			(0.707)			(1.447)
Time dummies included?	No	Yes	Yes	No	Yes	Yes
No. of countries	142	142	142	142	142	142
No. of obs.	2653	2653	2653	2653	2653	2653
No. of Instruments	48	79	85	48	79	85
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.424	0.154	0.251	0.414	0.287	0.376
Hansen test, P-value	-	-	-	0.053	0.145	0.193

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

Table 17: Robustness Tests

Estimates for the Effect of Resource Wealth on Income Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)						
	Fixed-effects model			**System GMM**		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged value of log GDP per capita	0.974***	0.952***	0.934***	1.006***	0.975***	0.972***
	(0.004)	(0.006)	(0.006)	(0.002)	(0.015)	(0.016)
Natural resource rents (share of GDP)	0.087***	0.120***	0.063***			
	(0.014)	(0.020)	(0.021)			
Prim. res. exports (share of GDP)				-0.012	0.208**	0.314**
				(0.126)	(0.104)	(0.151)
Gross capital formation (% of GDP)		0.129***	0.160***		0.374***	0.405***
		(0.018)	(0.018)		(0.084)	(0.100)
Openness to trade		0.018***	0.008**		0.037	0.068
		(0.004)	(0.004)		(0.031)	(0.051)
Institutional quality proxy		0.074**	(0.005)		0.049	(0.048)
		(0.031)	(0.032)		(0.158)	(0.154)
Ratio of sec. education enrolment		0.012	-0.035***		0.037	(0.051)
		(0.012)	(0.013)		(0.049)	(0.075)
Population growth (%)		-1.035***	-0.634***		-0.944*	-1.081*
		(0.184)	(0.179)		(0.488)	(0.576)
Life expectancy (years)		0.003***	0.001**		0.001	0.005*
		0.000	0.000		(0.001)	(0.003)
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	163	142	142	156	131	131
No. of obs.	4569	2653	2653	3266	2116	2116
No. of Instruments	-	-	-	14	56	87
AR (1) test, P-value	-	-	-	0.000	0.000	0.000
AR (2) test, P-value	-	-	-	0.158	0.049	0.015
Hansen test, P-value	-	-	-	0.010	0.083	0.216
R-squared	0.944	0.955	0.960	-	-	-

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

Table 18: Time periods

	70-79	89-89	90-99	00-09	1970-2011	
	(1a)	(1b)	(1c)	(1d)	(2a)	(2b)
Lagged value of log GDP per capita	0.986***	0.995***	1.043***	0.985***	1.008***	1.008***
	(0.037)	(0.031)	(0.032)	(0.023)	(0.008)	(0.020)
Natural resource rents (share of GDP)	0.147	-0.014	-0.589	0.275***	0.262***	0.182**
	(0.093)	(0.119)	(0.404)	(0.092)	(0.043)	(0.075)
*1970s dummy * Nat. resource rents*					-0.284***	-0.143
					(0.090)	(0.191)
*1980s dummy * Nat. resource rents*					-0.254***	-0.178**
					(0.056)	(0.088)
*1990s dummy * Nat. resource rents*					-0.077	0.044
					(0.071)	(0.151)
*2000s dummy * Nat. resource rents*					0.056	0.105
					(0.045)	(0.067)
Gross capital formation (% of GDP)	0.335*	0.295**	0.167	0.423**	0.330***	0.313***
	(0.174)	(0.136)	(0.193)	(0.207)	(0.031)	(0.083)
Openness to trade	0.015	0.012	0.007	0.007	0.053***	0.057
	(0.059)	(0.040)	(0.064)	(0.037)	(0.016)	(0.038)
Institutional quality proxy	0.229	0.012	(0.011)	0.017	0.030	0.031
	(0.191)	(0.178)	(0.503)	(0.241)	(0.065)	(0.107)
Ratio of sec. education enrolment	-0.209*	0.015	-0.291***	0.008	-0.161***	(0.113)
	(0.109)	(0.089)	(0.099)	(0.108)	(0.030)	(0.084)
Population growth (%)	(1.427)	(0.762)	(0.128)	-1.360*	-1.777***	(1.545)
	(1.063)	(1.024)	(2.043)	(0.700)	(0.261)	(1.058)
Life expectancy (years)	0.005	0.003	0.003	0.003	0.009***	0.006**
	(0.005)	(0.005)	(0.003)	(0.004)	(0.001)	(0.003)
Time dummies included?	Yes	Yes	Yes	Yes	No	Yes
No. of countries	75	85	115	135	142	142
No. of obs.	563	647	742	916	3284	3284
No. of Instruments	57	57	57	57	97	97
AR (1) test, P-value	0.000	0.000	0.007	0.004	0.000	0.000
AR (2) test, P-value	0.276	0.004	0.449	0.232	0.017	0.114
Hansen test, P-value	0.138	0.113	0.263	0.010	-	0.457

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses. All estimated models include the full set of controls and year dummies.

Table 19: Types of Natural Resources

System GMM Estimates of the Effect of Resource Wealth on Income Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)					
	(1)	(2)	(3)	(4)	(5)
Lagged value of log GDP per capita	0.979***	1.048***	1.038***	0.988***	1.004***
	(0.035)	(0.032)	(0.033)	(0.036)	(0.030)
Coal rents (share of GDP)	0.273				0.125
	(0.711)				(0.753)
Forest rents (share of GDP)		0.141			-0.071
		(0.473)			(0.403)
Mineral rents (share of GDP)			0.375		0.196
			(0.345)		(0.379)
Oil and gas rents (share of GDP)				0.329**	0.373**
				(0.164)	(0.177)
Gross capital formation (% of GDP)	0.412***	0.472***	0.387***	0.513***	0.493***
	(0.123)	(0.095)	(0.096)	(0.113)	(0.089)
Openness to trade	0.047	(0.024)	(0.006)	0.053	0.062
	(0.066)	(0.056)	(0.061)	(0.066)	(0.049)
Institutional quality proxy	0.236	(0.048)	(0.010)	0.387	0.274
	(0.259)	(0.287)	(0.248)	(0.277)	(0.211)
Ratio of secondary education enrolment	(0.034)	-0.196*	-0.232*	(0.117)	-0.182*
	(0.125)	(0.114)	(0.124)	(0.120)	(0.101)
Population growth (%)	(0.968)	-2.201**	-1.651*	(1.034)	-1.007**
	(0.997)	(1.020)	(0.892)	(0.807)	(0.429)
Life expectancy (years)	0.007	0.002	0.003	0.006	0.004
	(0.006)	(0.002)	(0.002)	(0.007)	(0.005)
Time dummies included?	No	Yes	Yes	Yes	Yes
No. of countries	122	142	142	117	117
No. of obs.	2380	2653	2653	2330	2330
No. of Instruments	79	79	79	79	97
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.698	0.187	0.176	0.849	0.778
Hansen test, P-value	0.274	0.077	0.104	0.097	0.192

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

Table 20: Estimation of the Resource Movement Effect

System GMM Estimates of the Effect of Resource Wealth on Manufacturing Dependent variable: Logarithm of Manufacturing Output (in 2005 U.S. Dollars)						
		One-step			**Two-step**	
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Log manufacturing output)$_{t-1}$	0.945***	0.961***	0.909***	0.953***	0.985***	0.911***
	(0.023)	(0.024)	(0.034)	(0.043)	(0.037)	(0.066)
(Natural resource rents)$_{t-1}$	-0.164*	-0.192**	-0.140	-0.093	-0.243*	-0.134
	(0.088)	(0.085)	(0.087)	(0.157)	(0.128)	(0.171)
GDP growth (%)		1.093***	1.054***		0.910***	0.987***
		(0.187)	(0.195)		(0.239)	(0.294)
Openness to trade		0.086*	0.160***		0.047	0.138
		(0.047)	(0.051)		(0.076)	(0.097)
Ratio of sec. education enrolment		0.010	0.018		0.021	0.063
		(0.052)	(0.063)		(0.078)	(0.136)
Gross capital formation (% of GDP)		-0.379***	-0.346**		-0.416**	(0.362)
		(0.116)	(0.142)		(0.186)	(0.240)
Population growth (%)		0.032***	0.016		0.040**	0.014
		(0.010)	(0.010)		(0.016)	(0.021)
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	159	145	145	159	145	145
No. of obs.	3910	2497	2497	3910	2497	2497
No. of Instruments	10	35	66	10	35	66
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.263	0.673	0.763	0.353	0.682	0.711
Hansen test, P-value	-	-	-	0.116	0.222	0.139

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses. Estimated using two-step system GMM estimator with Windmeijer-correction for robust standard errors.

Table 21: Types of Natural Resources and the Resource Movement Effect

System GMM Estimates of the Effect of Resource Wealth on Manufacturing Dependent variable: Logarithm of Manufacturing Output (in 2005 U.S. Dollars)					
	(1)	(2)	(3)	(4)	(5)
(Log manufacturing output)$_{t-1}$	0.881***	0.932***	0.913***	0.850***	0.851***
	(0.089)	(0.071)	(0.081)	(0.113)	(0.087)
Coal rents (share of GDP))$_{t-1}$	-0.199				-0.899
	(2.585)				(1.562)
Forest rents (share of GDP))$_{t-1}$		-0.780			-0.458
		(0.624)			(0.691)
Mineral rents (share of GDP))$_{t-1}$			0.099		-0.451
			(0.576)		(1.224)
Oil and gas rents (share of GDP))$_{t-1}$				0.105	0.643**
				(0.427)	(0.327)
GDP growth (%)	0.718**	0.948***	0.869***	0.945***	0.363
	(0.315)	(0.277)	(0.288)	(0.350)	(0.422)
Openness to trade	0.125	0.096	0.111	0.197	0.121
	(0.101)	(0.120)	(0.107)	(0.130)	(0.100)
Ratio of secondary education enrolment	-0.094	0.088	0.034	-0.091	0.007
	(0.183)	(0.118)	(0.139)	(0.178)	(0.204)
Gross capital formation (% of GDP)	-0.505	-0.083	-0.318	-0.459	0.074
	(0.309)	(0.298)	(0.326)	(0.409)	(0.376)
Population growth (%)	0.030	0.016	0.016	0.023	0.021
	(0.022)	(0.023)	(0.021)	(0.025)	(0.030)
Time dummies included?	Yes	Yes	Yes	Yes	Yes
No. of countries	123	145	145	117	117
No. of obs.	2189	2497	2497	2137	2137
No. of Instruments	66	66	66	66	81
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.542	0.679	0.653	0.709	0.594
Hansen test, P-value	0.135	0.203	0.139	0.019	0.094

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

Table 22: Estimation of the Spending Effect

System GMM Estimates of the Effect of Resource Wealth on Price Levels

Dependent variable: Price Level Relative to United States Price level

	One-step			Two-step		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Relative price level)$_{t-1}$	1.021***	0.999***	0.970***	1.020***	0.999***	0.971***
	(0.004)	(0.012)	(0.011)	(0.008)	(0.040)	(0.058)
(Natural resource rents)$_{t-1}$	0.084***	-0.031	-0.051	0.088**	-0.026	-0.038
	(0.024)	(0.036)	(0.041)	(0.043)	(0.050)	(0.049)
GDP growth (%)		0.543***	(0.073)		0.544***	(0.080)
		(0.064)	(0.075)		(0.158)	(0.122)
Net barter terms of trade index		0.027**	0.035***		0.025	0.031**
		(0.011)	(0.013)		(0.020)	(0.013)
M2 (% of GDP)		0.033***	0.028**		0.034	0.031
		(0.010)	(0.012)		(0.026)	(0.029)
Govt. expenditure (annual % growth)		-0.049*	0.033		-0.052	0.032
		(0.028)	(0.027)		(0.048)	(0.035)
Consumption expenditure (% of GDP)		-0.042***	0.017		-0.041	0.021
		(0.015)	(0.036)		(0.028)	(0.044)
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	153	141	141	153	141	141
No. of obs.	4406	2584	2584	4406	2584	2584
No. of Instruments	93	128	159	93	128	159
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.000	0.000	0.000	0.004	0.038	0.103
Hansen test, P-value	-	-	-	0.002	0.270	0.425

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses. Estimated using two-step system GMM estimator with Windmeijer-correction for robust standard errors.

Table 23: Types of Natural Resources and the Spending Effect

System GMM Estimates of the Effect of Resource Wealth on Price Levels Dependent variable: Price Level Relative to United States Price level					
	(1)	(2)	(3)	(4)	(5)
(Relative price level)$_{t-1}$	0.968***	0.933***	0.949***	1.034***	1.035***
	(0.078)	(0.081)	(0.069)	(0.021)	(0.022)
Coal rents (share of GDP))$_{t-1}$	1.553				1.203
	(1.400)				(1.674)
Forest rents (share of GDP))$_{t-1}$		-0.196			-0.082
		(0.355)			(0.256)
Mineral rents (share of GDP))$_{t-1}$			0.048		0.476
			(0.166)		(0.337)
Oil and gas rents (share of GDP))$_{t-1}$				-0.092	-0.048
				(0.074)	(0.079)
GDP growth (%)	0.149	-0.165	-0.048	0.291	0.282*
	(0.244)	(0.230)	(0.206)	(0.185)	(0.166)
Net barter terms of trade index	-0.022	0.029	0.011	-0.015	-0.040
	(0.028)	(0.023)	(0.025)	(0.024)	(0.032)
Money and quasi money M2 (% of GDP)	-0.006	0.028	0.018	-0.026	-0.016
	(0.035)	(0.035)	(0.029)	(0.016)	(0.019)
General expenditure (annual % growth)	-0.016	0.015	-0.002	-0.033	-0.062
	(0.040)	(0.053)	(0.054)	(0.033)	(0.047)
Consumption expenditure (% of GDP)	-0.016	0.040	0.042	-0.043	0.011
	(0.063)	(0.049)	(0.049)	(0.077)	(0.097)
Time dummies included?	Yes	Yes	Yes	Yes	Yes
No. of countries	117	141	141	113	112
No. of obs.	2174	2584	2584	2112	2110
No. of Instruments	101	101	101	101	107
AR (1) test, P-value	0.002	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.145	0.103	0.110	0.000	0.001
Hansen test, P-value	0.027	0.007	0.003	0.033	0.040

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

C. Sensitivity analysis for the interaction effect

Table 24: Sensitivity Analysis of the Resource Curse

System GMM Estimates of the Effect of Resource Wealth on Income

Dependent variable: Log of Income per Capita (in 2005 U.S. Dollars)

	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Lagged value of log GDP per capita	0.980***	1.053***	1.035***	0.995***	1.036***	1.027***
	(0.008)	(0.010)	(0.010)	(0.015)	(0.023)	(0.026)
Natural resource rents (share of GDP)	0.264***	0.457***	0.402***	0.312***	0.364***	0.326**
	(0.045)	(0.044)	(0.041)	(0.111)	(0.139)	(0.131)
Gross capital formation (% of GDP)	0.383***	0.445***	0.411***	0.338***	0.409***	0.417***
	(0.035)	(0.036)	(0.037)	(0.112)	(0.100)	(0.110)
Openness to trade	0.045***	0.003	0.028	0.039	0.02	0.035
	(0.016)	(0.018)	(0.018)	(0.031)	(0.039)	(0.046)
Institutional quality proxy	0.327***	0.057	0.303***	0.133	-0.045	0.159
	(0.071)	(0.082)	(0.101)	(0.250)	(0.207)	(0.223)
Ratio of sec. education enrolment	0.183***	-0.292***	-0.258***	0.065	-0.234**	-0.228**
	(0.034)	(0.039)	(0.039)	(0.099)	(0.100)	(0.102)
Population growth (%)	-1.398***	-1.517***	-1.420***	-1.282*	-1.414**	-1.434**
	(0.389)	(0.399)	(0.381)	(0.662)	(0.710)	(0.638)
Life expectancy (years)	-0.001	0.003***	0.004***	-0.001	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
*Nat. resources * Institutional quality*			-2.510***			-2.511*
			(0.697)			(1.436)
Time dummies included?	No	Yes	Yes	No	Yes	Yes
No. of countries	134	134	134	134	134	134
No. of obs.	2598	2598	2598	2598	2598	2598
No. of Instruments	48	79	85	48	79	85
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.281	0.047	0.069	0.380	0.208	0.232
Hansen test, P-value	-	-	-	0.058	0.141	0.140

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

D. Regression output United States dataset

Table 1: Regional Evidence of the Resource Curse

System GMM Estimates of the Effect of Resource Wealth on Income Dependent variable: Log of Real State Income per Capita						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Lagged value of log GDP per capita	1.001***	0.993***	0.853***	1.001***	0.994***	0.861***
	(0.003)	(0.008)	(0.101)	(0.002)	(0.004)	(0.089)
Nat. resource rents (share of GDP)	0.487	0.771*	0.560***	0.404	0.807***	0.569***
	(0.555)	(0.463)	(0.206)	(0.309)	(0.298)	(0.217)
Machinery investment (% of GDP)		5.226**	-0.433		5.117***	-0.34
		(2.436)	(1.321)		(1.790)	(1.329)
State expenditure (% of GDP)		-0.009	-0.071		-0.009	-0.070*
		(0.012)	(0.045)		(0.006)	(0.039)
R&D expenditure (% of GDP)		0.31	0.867		-0.324	0.831
		(2.400)	(1.368)		(1.373)	(0.917)
Population growth (%)		0.014	0.012		0.014**	0.012
		(0.017)	(0.012)		(0.006)	(0.008)
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	50	50	50	50	50	50
No. of obs.	1250	699	699	1250	699	699
No. of Instruments	12	36	50	12	36	50
AR (1) test, P-value	0.000	0.003	0.000	0.000	0.000	0.001
AR (2) test, P-value	0.085	0.428	0.970	0.011	0.230	0.980
Hansen test, P-value	-	-	-	0.000	0.057	0.196

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

Table 2: Estimation of Regional Market Mechanisms

System GMM Estimates of the Effect of Resource Wealth on Manufacturing						
Dependent variable: Logarithm of Real Manufacturing Output						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Log manufacturing output)$_{t-1}$	0.995***	1.009***	0.870***	0.997***	1.002***	0.894***
	(0.005)	(0.014)	(0.098)	(0.006)	(0.020)	(0.100)
(Nat. resource rents)$_{t-1}$	0.466	-0.574	-0.597*	0.331	-0.619	-0.564
	(0.411)	(0.434)	(0.325)	(0.226)	(0.948)	(0.582)
Growth rate (%)		1.689***	2.083***		1.785***	2.286***
		(0.428)	(0.460)		(0.507)	(0.602)
Machinery investment (% of GDP)		-8.707***	1.762		(6.794)	2.854
		(2.110)	(3.201)		(6.168)	(3.996)
Education investment (% of GDP)		5.179	-5.480**		3.567	-5.734*
		(4.684)	(2.687)		(7.277)	(3.215)
R&D expenditure (% of GDP)		(2.254)	0.806		(0.374)	1.429
		(2.641)	(2.604)		(3.148)	(2.175)
Population growth (%)		(0.026)	-0.041**		(0.027)	-0.055**
		-0.022	-0.02		-0.041	-0.025
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	50	50	50	50	50	50
No. of obs.	1250	738	738	1250	738	738
No. of Instruments	8	25	40	8	25	40
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.002	0.010
AR (2) test, P-value	0.827	0.415	0.950	0.890	0.438	0.805
Hansen test, P-value	-	-	-	0.000	0.157	0.268

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

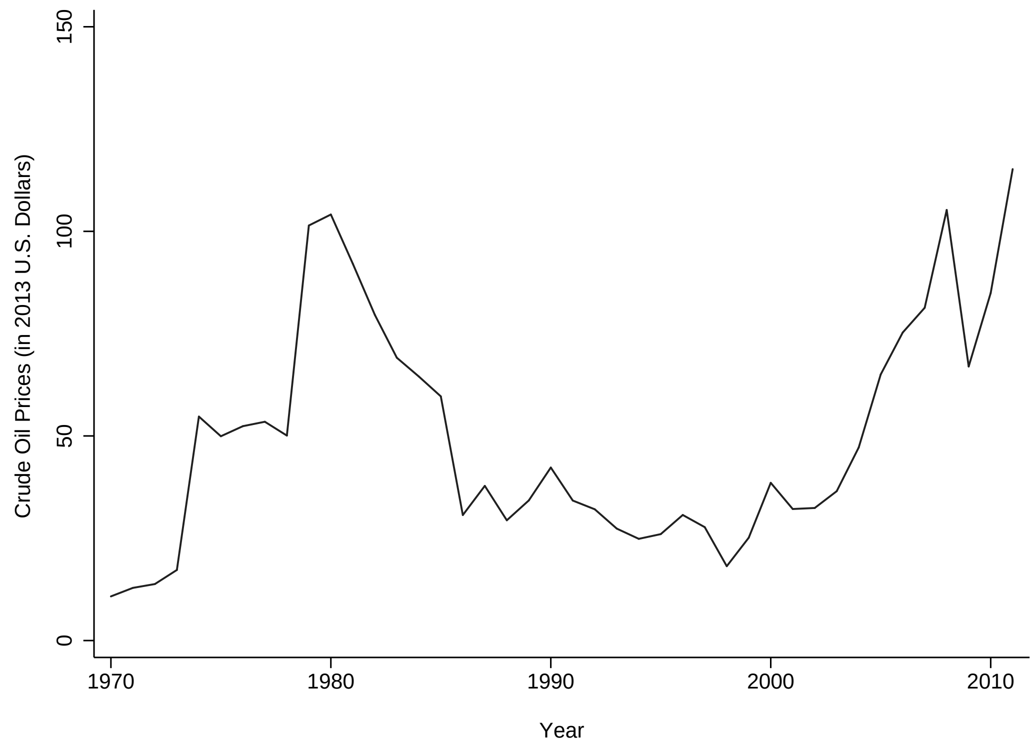
Table 3: Estimation of the Spending Effect on a Regional Scale

System GMM Estimates of the Effect of Resource Wealth on Price Levels Dependent variable: Consumer Price Index						
	One-step			**Two-step**		
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
(Consumer price index)$_{t-1}$	1.025***	1.023***	1.074***	1.014***	1.021***	1.043***
	0.000	(0.006)	(0.012)	(0.003)	(0.003)	(0.021)
(Nat. resource rents)$_{t-1}$	0.024***	0.005	0.017*	0.450***	0.082*	-0.002
	(0.008)	(0.010)	(0.009)	(0.173)	(0.049)	(0.026)
Growth rate (%)		-0.025	0.128*		-0.027*	0.072
		(0.022)	(0.076)		(0.015)	(0.074)
State expenditure (% of GDP)		-0.017**	0.023		-0.015**	0.029
		(0.007)	(0.016)		(0.007)	(0.018)
State debt (% of GDP)		0.095	-0.195***		0.096	-0.069
		(0.138)	(0.049)		(0.060)	(0.108)
Time dummies included?	No	No	Yes	No	No	Yes
No. of countries	50	50	50	50	50	50
No. of obs.	1250	1051	1051	1250	1051	1051
No. of Instruments	5	23	45	10	28	50
AR (1) test, P-value	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test, P-value	0.000	0.550	0.886	0.000	0.248	0.739
Hansen test, P-value	-	-	-	0.000	0.001	0.060

Notes: *** stands for 1 percent significance level; ** for 5 percent and * for 10 percent. Regressions include a constant and standard errors are displayed in parentheses.

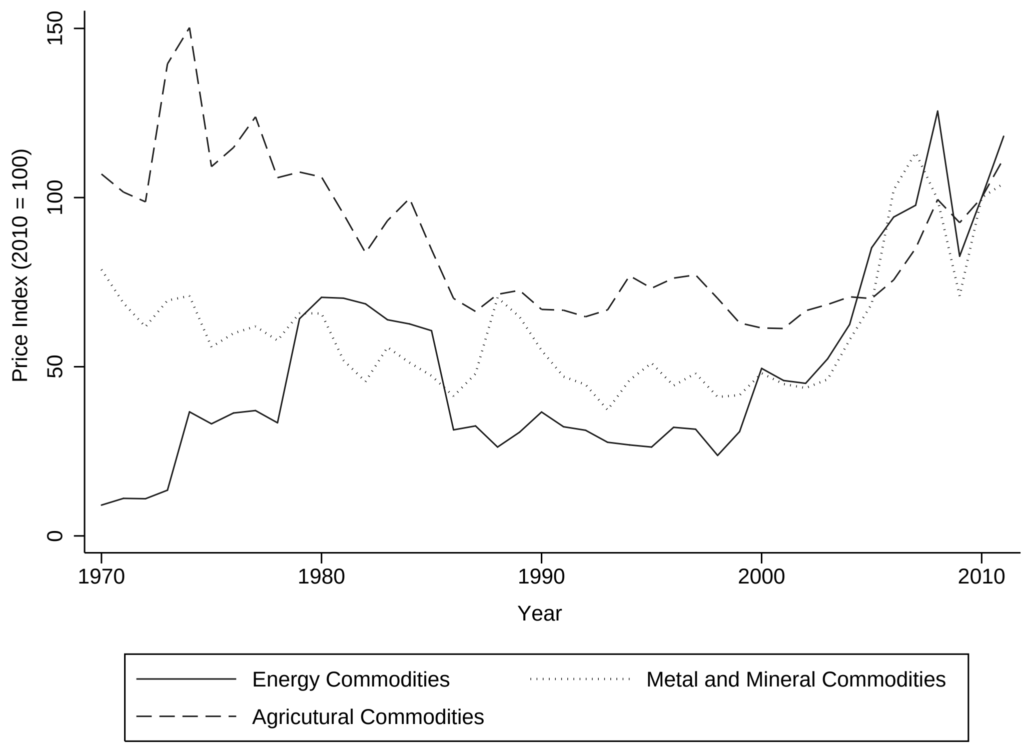
E. Commodity price levels

Figure 4: Evolution of the Crude Oil Price 1970-2011



Source: BP's Statistical Review of World Energy (2014)

Figure 5: Commodity Price Indices 1970-2011



Source: World Bank (2014)