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The Resource Curse: A Statistical Mirage?

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The Resource Curse: A Statistical Mirage?*

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Abstract

A surprising feature of resource-rich economies is slow growth. It is often argued that natural-resource production impedes development by creating market or institutional failures. This paper establishes an alternative explanation—a slow-growing resource sector. A declining resource sector is disproportionately reflected in resource-dependent countries. Additionally, there is little evidence that resource dependence impedes growth in non-resource sectors. More generally, this paper illustrates the importance of considering industry composition in cross-country growth regressions.

Keywords: Resource Dependence; Economic Growth; Resource Curse.

JEL Classification: Q2; Q3; O1

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Without natural resources life itself is impossible. From birth to death, natural resources, transformed for human use, feed, clothe, shelter, and transport us. Upon them we depend for every material necessity, comfort, convenience, and protection in our lives. Without abundant resources prosperity is out of reach. Gifford Pinchot.

1 Introduction

Poor countries are relatively resource dependent (Barbier, 2005). Understanding the relationship between resource wealth and growth is therefore a necessary step towards understanding the growth performance of poor countries. Surprisingly, a large literature documents a negative relationship between resource dependence and economic growth. This remarkably robust phenomenon is commonly attributed to the so-called "resource curse" — the systematic tendency for resource dependence to impede economic growth and development by creating market or institutional failures (Sachs and Warner 1995, 1999, 2001; Papyrakis and Gerlagh, 2007; James and Aadland, 2010). According to this theory, developing countries like Brunei are poor not in spite of resource endowments but rather, because of resource endowments.

With nearly 3000 citations, this literature is largely motivated by the seminal work of Jeffery Sachs and Andrew Warner (1995) who, using a cross section of international data estimate a negative conditional relationship between growth and resource dependence. Specifically, Sachs and Warner estimate a variation of the following equation

$$G_i = b_0 + b_1 r_i + \epsilon_i, \tag{1}$$

where G_i is the average annual growth rate of GDP per capita from 1971-1990, r_i is resource dependence (exports of fuels, minerals, metals and agriculture in GDP) at the beginning of the period (1971), and i denotes countries.[1] Sachs and Warner conclude that the coefficient on resource dependence, b_1, is negative and significant, and consider this to be evidence of a "resource curse". While others have similarly tested for a resource curse (Papyrakis and Gerlagh, 2007; Williams, 2010; James and Aadland, 2010), this methodology has since been heavily criticized.

Perhaps most notably, Brunnschweiler and Bulte (2008) question whether a negative correlation between resource dependence and growth implies an underlying story of causation. More specifically, they argue that such cross-sectional regressions suffer from problems of reverse causality. Because resource dependence is defined as resource earnings relative to income, poorer countries that may grow relatively slowly will tend to be more resource dependent than their wealthier, perhaps faster growing counterparts. Using a cross-section of

[1]Equation (1) is a simplified version of Sachs and Warner's main estimation equation which includes a variety of relevant controls.

data, they instrument for resource dependence and find a positive and significant relationship between resource *abundance* and growth and an insignificant relationship between resource *dependence* and growth.[2]

This paper abstracts from questions of causality and asks an even more fundamental question regarding the interpretation of b_1 from equation (1). Because growth is a weighted average of growth in individual sectors, a declining international resource price is disproportionately reflected in the growth rates of resource-dependent countries. While GDP growth is correlated with resource dependence (negatively so during periods of falling resource prices and positively so during periods of rising resource prices) there is little robust evidence that sector-specific growth is correlated with resource dependence. There is little evidence of a Dutch Disease. To the contrary, a booming resource sector appears to generate economic spillovers that positively affect growth in non-resource sectors in highly resource-dependent countries.

2 Existing Explanations for the Resource Curse

Why do resource-rich economies grow slowly? A prominent explanation is the so-called Dutch Disease phenomenon. Named after the decline in the tradable sector that is said to have been caused by the discovery of natural gas in the Netherlands (Stijns, 2005), an economy suffers from a Dutch Disease when natural-resource industries "crowd out" other growth-promoting industries such as manufacturing (Matsuyama, 1992; Sachs and Warner, 1999). In Matsuyama's model, an increase in resource technology in a small and open economy pulls labor out of a non-resource industry that benefits from learning-by-doing and into a resource industry that does not. A resource discovery decreases the level of technology in the non-resource industry and decreases total economic growth. The equilibrium is inefficient because the positive externality associated with working in the non-resource industry is not internalized by labor. The Dutch Disease is similarly modeled by van Wijnbergen (1984), Krugman (1987) and Sachs and Warner (1999).

Auty (1994) argues that resource endowments can prolong anti-growth policies. For example, countries that are resource dependent may be more likely to favor autarkic trade policies. One reason for this may be that the presence of natural resources (think agriculture and energy) make autarky a more viable trade policy.

Similarly, some economists and political scientists have argued that natural-resource endowments create the opportunity for rent-seeking, whereby rent-seeking and productive enter-

[2] van der Ploeg and Poelhekke (2010) argue that the measure of resource abundance used by Brunnschweiler and Bulte is endogenous. Using what they argue to be a more exogenous measure of resource abundance they find no significant effect on growth of resource dependence or abundance.

prise are competing endeavors (Lane and Tornell, 1996; Tornell and Lane, 1999; Torvik, 2002; Mehlum *et al.*, 2006). In Torvik's model, the potential gains from unproductive rent-seeking activities are increasing in total tax revenue and a resource endowment. An exogenous increase in the resource endowment causes some entrepreneurs to switch from producing a good in an industry that benefits from increasing returns to scale to participating in unproductive rent-seeking activities. Production and therefore consumption decrease as a result of an increase in the resource endowment. Rent-seeking has also been shown to lead to distortions in the allocation of resources, greater social inequality and political corruption (Ross, 1999; Sala-i-martin and Subramanian, 2004).

Natural-resource production can also lead to social conflict, as factions of society compete over control of natural resources (Collier and Hoeffler, 1998).[3] Collier and Hoeffler find that the effect of natural-resource abundance on civil war is non-monotonic. Increasing resource abundance when resource abundance is low increases the risk of civil war. When resource abundance is high, increasing resource abundance tends to decrease the risk of civil war. Collier and Hoeffler posit that small endowments of natural resources provide taxable revenue that rebels wish to take control of while large endowments of natural resources provide a government with the means to heavily invest in their military.

Gylfason (2001) argues that vast endowments of natural resources can lead to over-confidence and a false sense of economic security, which leads to under-investments in human capital. Gylfason documents a direct negative effect of resource dependence on growth and a negative indirect effect of resource dependence on growth, through its effect on school enrollment rates. As Gylfason puts it, "Rich parents sometimes spoil their kids. Mother Nature is no exception." See van der Ploeg (2011) for a more complete review of existing theoretical explanations of a resource curse.

Present in each of the theories above is a mechanism by which natural-resource production actively impedes the development process in non-resource industries. This is a necessary assumption for a resource curse to exist. Less this assumption, an economy would not be worse off after a resource is discovered and extracted. The alternative theory presented in this paper, namely that the slow growth of resource-dependent economies reflects the slow growth of resource industries, is not entirely new.

Boyce and Emery (2011) raise the same concern and argue that "whether resources are a curse or a blessing for an economy can only be determined with an investigation of the correlation between resource abundance and income levels."[4] Using U.S.-state level panel

[3]In contrast, Brunnschweiler and Bulte (2009) find little evidence to support the claim that natural resources lead to increased social conflict. Rather, they conclude that social conflict increases resource dependence.

[4]Alexeev and Conrad (2009) similarly argue that a proper test of a resource curse includes exploring the

data, they subsequently test for a resource curse by regressing the level of income per person on the share of employment in a natural-resource industry. They find some evidence of a positive relationship between resource abundance and income levels.

Davis (2011) refers to this phenomenon, whereby a slow-growing resource industry slows the growth rate of the entire economy, as a "resource drag". A straightforward test of this theory involves regressing growth on resource dependence while controlling for growth in resource production. Davis applies this methodology to the growth period 1971 to 1990 and finds evidence that a so-called "resource drag" explains a significant amount of the negative relationship between growth and resource dependence. Specifically, he finds that "even after controlling for resource drag effects there are some residual nefarious impacts of having high mineral production at the start of the growth period. The economic importance of the effect is, however, about half of what was estimated [prior to controlling for resource sector growth]." In the empirical section of this paper I will employ Davis's methodology as a robustness check on a series of baseline results.

Using methodology similar to that outlined in this paper, James and James (2011) test for a resource curse at the sub-national level. Applying their methodology to the international level is important for a couple of reasons. First, a large majority of empirical tests for the resource curse focus on the relationship between growth and resource dependence across countries. Second, there are reasons to believe the resource curse is more prominent among countries. For example, institutional quality and cultural customs vary across countries, but less so across U.S. states. This is important because such factors play crucial roles in some explanations of the resource curse. For example, Mehlum *et al.* (2006) among others have argued that poor institutional quality can lead to, or exacerbate a resource curse. Finally, while James and James consider the growth period 1980 to 2000, this paper judiciously examines the relationship between growth and resource dependence for a variety of growth periods using a range of regression specifications.

3 Deriving The Coefficient On Resource Dependence

Similar to James and James (2011), consider economy i that produces a non-natural-resource good, M_i, and a natural-resource good, R_i. Income and growth are respectively given by

$$Y_i = M_i + R_i \quad (2)$$

relationship between resource wealth and income levels.

and

$$G_i = \frac{M_i g_i^M + R_i g_i^R}{M_i + R_i}, \tag{3}$$

where g_i^M and g_i^R are the growth rates of non-resource and resource output per capita. Noting that $\frac{M_i}{Y_i} = 1 - \frac{R_i}{Y_i}$ and making the appropriate substitution, equation (3) can be re-written as

$$G_i = g_i^M + (g_i^R - g_i^M)r_i, \tag{4}$$

where $r_i = \frac{R_i}{Y_i}$, is resource dependence. In the absence of a resource curse, differentiating (4) with respect to resource dependence yields $(g_i^R - g_i^M)$, implying that the estimate of b_1 from equation (1) is equal to the difference in average resource and non-resource sector growth rates. This result is not robust to a resource curse though. To see this, assume that the growth rate of the non-resource sector is negatively affected by resource dependence. Specifically, let $g_i^M = g_i^M(r_i)$ where $g_i^{M\prime} < 0$. Differentiating (4) with respect to resource dependence now yields $g_i^{M\prime}(1 - r_i) + (g_i^R - g_i^M)$, where the first term is negative. This implies that if non-resource sector growth is "cursed" by resource dependence, an OLS estimation of equation (1) will yield a coefficient on resource dependence that is *less* than the difference in average sector growth rates. This also implies that whether the relationship between resource dependence and growth is negative or positive, critically depends on the rates at which the resource and non-resource sectors grow during the sample period.

4 Empirical Estimation

4.1 Estimation of Equation 1

According to equation (4), in the absence of a resource curse, whether the coefficient on resource dependence (b_1 from equation (1)) is positive or negative depends on the relative average rates at which the non-resource and resource sectors grow (a large amount of which turns out to be explained by variation in the resource price). For a given growth period, if the average resource sector grew relatively slowly, the relationship between resource dependence and growth will tend to be negative. The opposite will be true for periods in which the average resource sector grew relatively quickly. This section confirms this idea by estimating equation (1) for a variety of growth periods—ones for which the price of the resource grew rapidly and ones for which it grew slowly.

Cross-country data on GDP and population were collected from the World Bank, World Development Indicators. The extant resource curse literature suggests that point-resources—and fuels in particular—may be especially conducive to a resource curse (see for example, Ross, 2001; Sala-i-Martin and Subramanian, 2003; Bulte *et al.*, 2005). Following this literature, resource dependence is defined as the value of crude oil and natural gas production relative to GDP. Data on oil and natural gas production was collected from Ross (2013).[5] This allows for the examination of many and some relatively long growth periods, e.g., 40 years (1970 to 2010).[6]

The World Bank provides GDP and population estimates for 190 countries spanning the years 1970 to 2010. Ross (2013) gives data on oil and natural gas production over the same time period. I use values of oil and gas production that reflect real prices based in 2000 U.S. dollars which are provided. Dropping countries that did not have any GDP values for any of the relevant years (1970, 1980, 1990, 2000, 2010) and matching this data with the oil and gas production data leaves 111 observations. The growth rates of income, resource and non-resource production are respectively defined as, $G_i = (1/T)\ln(Y_{i+T}/Y_i)$, $g_i^R = (1/T)\ln(R_{i+T}/R_i)$ and $g_i^M = (1/T)\ln(M_{i+T}/M_i)$, where T is the length of the growth period, Y_i is GDP per capita, R_i is the value of resource production per capita and M_i is the value of non-resource production per capita. All prices are in 2000 U.S. dollars. Countries that had zero resource earnings at either time t or time $t+T$ but not both, were dropped from the oil and gas data set prior to being merged with the World Bank data as resource (and hence non-resource) growth rates cannot be computed. A list of all countries included in the analysis is given in Table 1. As can be seen, the data set consists of both rich and poor countries covering a wide range of regions.

As a starting point, I estimate the relationship between growth in GDP per capita from 1970 to 1980 (a period in which the price of oil increased significantly) and 1970 resource dependence. I then contrast these results to those from the estimation of the relationship between growth in GDP per capita from 1980 to 1990 (a period in which the price of oil significantly decreased) and 1980 resource dependence. This approach highlights the sensitivity of the results to changes in the price of oil.

Figure 1a plots growth in GDP per capita from 1970 to 1980 against 1970 resource dependence. As can be seen, the relationship is strongly positive. Countries that were relatively dependent on natural-resources in 1970 experienced rapid growth in GDP per capita over the subsequent ten years, reflecting that from 1970 to 1980, the price of oil increased 11.62%, annually. Later, it will be relevant to know that this result is robust to the omission of poten-

[5] Ross collected data on oil and gas production from 1970-2000 from the World Bank's "Wealth of Nations" database then merged this data with that from the US Energy Information administration for the years 2001 to 2010.

[6] While existing cross-country examinations of the resource curse largely rely on the use of primary export data (see, e.g., Sachs and Warner, 1995; Brunnschweiler and Bulte, 2008), this approach is not suitible for a sector-specific analysis because export growth may reflect, but is not equal to, sector growth.

tial outliers. For example, after dropping Kuwait, Saudi Arabia and Brunei (the three most heavily resource-dependent countries) from the data set, the estimate of b_1 increases from .182 to .223 and remains significant. Figure 2a similarly plots growth in GDP per capita from 1980 to 1990 against 1980 resource dependence. The relationship is negative (-.113), reflecting that from 1980 to 1990, the price of oil decreased 5.36%, annually. Again, this result is robust to the omission of outliers (dropping Kuwait, Saudi Arabia and Brunei causes b_1 to increase from -.113 to -.095 and remains significant).

These results are reinforced by estimating equation (1) for all 10, 20, 30 and 40 year growth periods between 1970 and 2010. The results are detailed in Table 2. For growth periods based in 1980 (a year of remarkably high oil prices), the relationship between resource dependence and growth tends to be negative. The opposite is true for growth periods based in 1970 (when the price of oil was relatively low). The last column of Tables 2-6 describes the average annual change in the real price of crude oil for each respective period. The correlation between the growth rate of the price of oil and the estimate of b_1 is about .94, implying that 94% of the variation in the relationship between resource dependence and growth is explained by variation in the price of oil alone.

This paper documents a positive (but statistically insignificant) relationship between 1970 resource dependence and growth from 1970 to 1990 while Sachs and Warner (1995) find this relationship to be negative. These contrasting results are explained by differences in the definition of "natural resources". Sachs and Warner's measure of natural resources includes fuels, metals, minerals and agriculture. While the price of oil only slightly increased from 1970 to 1990, the international price of metals, minerals and agriculture decreased significantly. Figure 4 describes real price indices (year 2010 = 100) for metals, minerals and agriculture.[7] With the exception of a spike in agriculture prices in 1974, both commodities experienced a rather steady decline in price from 1960 to 2000. In fact, from 1970 to 1990, the real international price of agriculture decreased 46% and the price of metals and minerals decreased 36%.

Recall from equation (4) that, in the absence of a resource curse, the coefficient on resource dependence reflects the difference in the average resource and non-resource sector growth rates, $(\bar{g}^R - \bar{g}^M)$.[8] If a resource curse exists though, the difference in average sector growth rates

[7]Price index data were collected from the World Bank, Global Economic Monitor (GEM) Commodities database and is available at: data.worldbank.org/data-catalog/commodity-price-data.

[8]Average growth rates of resource and non-resource production are respectively given by $\bar{g}^R = \frac{\sum_i^k r_i g_i^R}{\sum_i^k r_i}$ and $\bar{g}^M = \frac{\sum_i^k (1-r_i) g_i^M}{\sum_i^k (1-r_i)}$, where r_i is resource dependence (and hence $(1 - r_i)$ is non-resource dependence) and k denotes countries. Weighting growth rates by resource and non-resource dependence is important as even large changes in non-resource production is not reflected by changes in GDP in highly resource-dependent

is greater than the estimate of b_1 from equation (1). It is therefore worth noting that for each growth period the difference between b_1 and $(\bar{g}^R - \bar{g}^M)$ is statistically insignificant. Put differently, average sector growth heterogeneity (that is not country specific) explains a significant amount of the variation in b_1 and the remaining unexplained variation is insignificantly different from zero. The correlation between the estimate of b_1 and $(\bar{g}^R - \bar{g}^M)$ is large (.98), implying that 98% of the variation in b_1 is explained by average sector-growth heterogeneity that is not country specific.

4.2 Resource Dependence and Sector-Specific Growth

The previous results demonstrate that whether resource-dependent countries grow relatively quickly or slowly depends critically on whether a country's resource sector grows quickly or slowly over the corresponding growth period. This is not to say that the growth rates of resource and non-resource sectors are uncorrelated. During a significant oil price bust (e.g., 1980 to 1990) non-resource production may grow more or less quickly than in other periods. According to the "Core Dutch Disease Model" by Corden and Neary (1982), a booming (or busting) resource sector can affect non-resource production in a variety of ways. For example, in the case of a resource boom, the resource sector may offer relatively high wages and hence attract labor from non-resource sectors (or even other economies). This may work to decrease non-resource production, a result Corden and Neary refer to as the direct "labor movement effect". However, the income gains associated with a resource boom may increase spending and wages in the non-traded—and often non-resource (e.g., service)—sectors, which may attract labor and counteract the direct so-called labor movement effect.

While there are reasons to think that resource and non-resource sector growth rates may be correlated, this is not to say that the correlation should depend on the corresponding degree of resource dependence. I further test for the existence of a resource curse by splitting each country's economy into two parts: a resource sector and a non-resource sector. I then re-estimate equation (1) using sector-specific growth as the dependent variable. This approach explicitly tests whether sector-specific growth is correlated with resource dependence for all, or some, growth periods. Before turning to these results, however, it should be noted that total economic growth may only weakly reflect sector-specific growth rates. For example, a country that is 90% resource dependent may experience rapid growth in non-resource production, but this would not necessarily be reflected in total growth as non-resource production accounts for only 10% of national income. Second, recall that average sector growth rates

countries. By design then, the average non-resource sector growth rate is predominantly determined by the performance of non-resource-dependent countries.

are weighted averages such that a country with zero resource earnings and zero growth in resource production did not contribute to the estimate of the international average growth rate of resource production. Only those countries with positive levels of resource production (and hence those countries with non-zero growth rates of resource production) are used to estimate the relationship between resource dependence and growth in resource production. This significantly reduces the sample size.

The results for all ten growth periods are given in Table 3. For comparison purposes, I have also included scatter plots of sector-specific growth rates against resource dependence for both the 1970-1980 and 1980-1990 growth periods. Consider first the relationship between 1970 resource dependence and non-resource sector growth from 1970 to 1980 (Figure 1b). The relationship is positive (.181) and significant, indicating that a booming resource sector generates positive economic spillovers which enhance non-resource-sector growth. This result should be viewed with caution though because it is sensitive to the omission of outliers. After dropping the three most resource-dependent countries from the data set (Brunei, Kuwait and Saudi Arabia), the relationship remains positive (.043) but is statistically insignificant. While highly resource-rich countries tended to experience rapid non-resource-sector growth from 1970-1980, this was not the case for the corresponding resource sectors. Rather, there is an insignificant relationship between 1970 resource dependence and resource-sector growth from 1970-1980 (see Figure 1c).

Consider now the relationship between sector growth and resource dependence for the growth period 1980-1990 (a period during which the price of oil significantly decreased). While non-resource sector growth is insignificantly correlated with resource dependence (the coefficient is small in magnitude and negative but lacks statistical significance), the relationship between resource dependence and resource-sector growth is negative (-.085) and significant at the 5% level. Again though, this result is sensitive to the omission of outliers. Dropping the three most resource-dependent countries from the data set (Kuwait, Saudi Arabia and Brunei), the magnitude of the relationship decreases to -.046 and becomes statistically insignificant. One may consider this evidence that resource-sectors perform poorly in resource-dependent countries when the price of the resource falls. But this potential effect is fundamentally different from a resource curse. Rather, a resource curse exists when the production of a natural resource today, leads to lower levels of income in the future. For this to happen, the production of a natural resource must impede growth in the corresponding non-resource sector.

Briefly examining the growth performance of Gabon is revealing in this context. In 1980, Gabon was 60% resource dependent and from 1980 to 1990, the growth rates of the resource and non-resource sectors were both above the international average. Specifically, the growth rate of the non-resource sector was 0.1% (it was -1.6% in the rest of the world) and the growth rate of the resource sector was -8% (it was -11.3% in the rest of the world). However, even though the sectors within Gabon outperformed those in the average country, total economic growth in Gabon was nearly half of the international average. Specifically, from 1980 to 1990, GDP per capita in Gabon grew -4% while in the rest of the world it grew -2.2%, annually. This is because GDP growth is a weighted average of growth in individual sectors, and in Gabon, a lot of weight (60%) is put on the energy sector, which from 1980 to 1990, experienced a rapid decline in its corresponding price.

Examining the remaining growth periods yields consistent results. With the exception of the growth period 1980-1990, resource dependence is uncorrelated with resource-sector growth. For all growth periods based in 1970 and 2000, resource dependence is positively correlated with non-resource-sector growth, but again these results are highly sensitive to the omission of outliers. For all other growth periods, non-resource-sector growth is uncorrelated with resource dependence, with or without the inclusion of potential outliers.

The key result that should be taken away from preceding analysis is that non-resource sectors do not appear to grow especially slowly in resource-dependent countries. To the contrary, there is some evidence that non-resource sectors expand disproportionately in highly resource-dependent countries when the price of the resource rises, perhaps reflecting positive economic spillovers. However, this result is not robust. After dropping potential outliers, the relationships between total growth and resource dependence are maintained, but sector-specific growth rates are not robustly correlated with resource dependence (for all growth periods). In other words, while resource-dependent and resource-scarce countries grow at different rates, the sectors within these two types of countries grow at similar rates.[9] This highlights the role that average sector-growth heterogeneity plays in determining country-wide growth rates. Resource-dependent countries grew slowly from 1980 to 1990 in part because they were dependent on the production of a commodity that experienced a rapid decline in its international price.

As discussed above, there are reasons to think resource booms and busts affect traded and non-traded sectors of the economy differently. A resource boom may inflate the price of non-traded goods (e.g., services) but would not, in theory, increase the price of traded goods (e.g., manufacturing) as those prices are internationally determined. I therefore also examine the relationship between resource dependence and growth in service and manufacturing production

[9] Failing to reject the null hypothesis of no effect of course does not imply the null hypothesis should be accepted. It is possible that non-resource-sector growth rates are negatively correlated with resource dependence, but there is too much statistical noise to measure the effect. Nonetheless, for only three of the ten growth periods considered is the relationship between resource dependence and non-resource-sector growth insignificantly negative, for the rest it is either significantly or insignificantly positive.

specifically. As before, data on service and manufacturing value added, expressed as a share of GDP, were collected from the World Development Indicators provided by the World Bank. Resource dependence is defined as before. Data on manufacturing and service production is inconsistently reported. For example, there are many more missing observations for manufacturing production in 1970 than in 2000. Therefore, sample sizes vary according to the growth period in consideration. This robustness check has the added benefit of quelling concerns that the previous findings are somehow the result of an accounting identity. For example, in the previous analysis, non-resource production is defined as total production (GDP) less resource production. This is not a concern here as levels of manufacturing and service production are reported independently from resource production. Finally, this robustness check utilizes a slightly different country set (countries included vary according to data availability). This re-assures that the previous findings are not specific to a particular set of countries.

The results re-enforce the previous ones and are detailed in Table 4. For most growth periods based in 1970, service and manufacturing sector growth rates are positively correlated with resource dependence. Perhaps reflecting positive economic spillovers to both the service and manufacturing sectors. As with the previous sector-specific analysis, during corresponding resource-price busts, there tends to be a negative and insignificant correlation between resource dependence and manufacturing and service sector growth. Finally, during the oil price boom of the 2000's, there is additional evidence of positive economic spill overs coming from large and booming resource sectors, particularly in the manufacturing sector, a result that complements nicely the findings of Kuralbayeva and Stefanski (2013) who find that resource-rich economies have relatively productive manufacturing sectors.

Thus far, all prices have been in terms of 2000, U.S. dollars. To account for possible bias created by differences in purchasing power across countries, I re-estimate Table 3 using purchasing power parity (PPP) price levels. Using data provided by the Penn World Tables,[10] PPP conversion factors were computed for each country (defined as PPP relative to the market exchange rate). Values of resource and non-resource production were then weighted by the appropriate conversion factor.[11] I then re-estimate the relationship between resource dependence and resource-sector and non-resource-sector growth. The results, given in Table 5, compliment the previous findings. For all growth periods, non-resource growth is either positively or insignificantly correlated with resource dependence. Though, resource-rich countries tended to experience slower growth in resource production from 1980 to 1990 (as before) but

[10] Available at: https://pwt.sas.upenn.edu/

[11] Conversion factors could not be produced for 11 countries for the years 1970 and 1980. For those years and countries (Kuwait, Saudi Arabia, Czech Republic, Armania, U.A.E, Bosnia, Eritrea, Estonia, Latvia, Macedonia and Moldova) 1990 conversion factors were used.

also from 1970 to 1990.

As a final robustness check, following Davis (2011), I estimate the relationship between growth in GDP per capita and resource dependence, conditional on the growth rate of resource production.[12] This is an intuitively pleasing approach as variation in total growth that is attributed to variation in resource-sector growth is captured by growth in resource production. Any remaining nefarious effect of resource dependence on growth would then be reflected by the coefficient on resource dependence. The results are given in Table 6. For all growth periods, the coefficient on resource dependence is statistically insignificant. Though, it does enter negatively in all but 2 regressions. This may be evidence of some relatively minor but nonetheless perverse growth effect of resource dependency. As expected, the coefficient on resource growth is positive in all regressions, reflecting that a booming (busting) resource sector positively (negatively) affects total growth.

5 Resource Abundance vs. Resource Dependence

The seminal work of Jeffery Sachs and Andrew Warner (1995) helped to motivate the large stream of research that has attempted to verify and explain the curse of natural resources. The title of their paper "Natural resource abundance and economic growth," is somewhat misleading though as they proxy for resource-*abundance* (proven reserves of natural resources) with the share of resource exports in GDP (resource dependence), due to data availability constraints. This proxy may be a poor one because (i) resource exports do not reflect total resource production and (ii) resource dependence may be a poor proxy for resource abundance.

Is there a negative correlation between resource abundance and economic growth? The answer appears to be, "probably not." Brunnschweiler and Bulte (2008) find that growth in GDP per capita from 1970 to 2000 is positively correlated with 1994 resource abundance. Similarly, Brunnschweiler (2008) finds that economic growth is negatively correlated with resource dependence but positively correlated with resource abundance. Michaels (2010) explores the effect of oil discoveries on economic growth and education and finds that the effects of oil discoveries in the southern United States were, "large and beneficial" and specifically led to a sustained increase in income per person.

How does one reconcile the fact that growth in income is positively correlated with resource abundance but negatively correlated with resource dependence? Brunnschweiler and Bulte posit that "one possible explanation could be that resources in the ground do not pose the

[12] Similar to Davis's earlier work, growth in resource production is weighted by each country's respective level of resource dependence. Weighting growth rates is important as rapid resource-sector growth will not be reflected in GDP growth for a country that is only weakly dependent on natural resources.

same problem for institutional quality or economic performance as flows of resource rents do. But this begs the question - since resource stocks can be converted into flows of money, why would outcomes for stocks and flows be different?" This paper offers an explanation for this apparent anomaly. The overall growth rate of an economy reflects the growth rate of specific sectors, and the growth rate of the resource sector is defined by the price and flow of a resource—not the stock.

6 Conclusion

A large literature documents a robust negative relationship between economic growth and resource dependence (Sachs and Warner, 1995, 1999, 2001; Papyrakis and Gerlagh, 2007; James and Aadland, 2010). This surprising result has fueled an even larger literature that seeks to explain it. It is commonly argued that natural-resource dependence creates market and institutional failures that induce slow economic growth (Matsuyama, 1992; Auty, 1994; Sachs and Warner, 1995; Gylfason, 2001; Bhattacharyya and Hodler, 2010).

This paper finds that resource-dependent countries grow slowly during certain growth periods, e.g., 1980 to 1990, but relatively quickly during others (e.g., 1970 to 1980). These results are largely explained by average sector-growth heterogeneity, a large amount of which is created by variation in the resource price. In essence, resource-rich countries grew slowly from 1980 onward because they were dependent on a commodity that experienced a rapid decline in price. Examining the relationship between resource dependence and sector-specific growth affirms this idea. For all growth periods considered, the relationship between resource dependence and growth in non-resource production is non-negative. While these results are certainly suggestive, more work ultimately needs to be done in this area and I hope this paper helps to motivate it.

Finally, the importance of this paper reaches further than the resource curse literature. In fact, it demonstrates that a large degree of cross-country growth heterogeneity can be explained by the types of industries that a country employs. From a development standpoint, the important question may not be why some countries grow faster than others, but rather, why sector-specific growth rates vary across countries.

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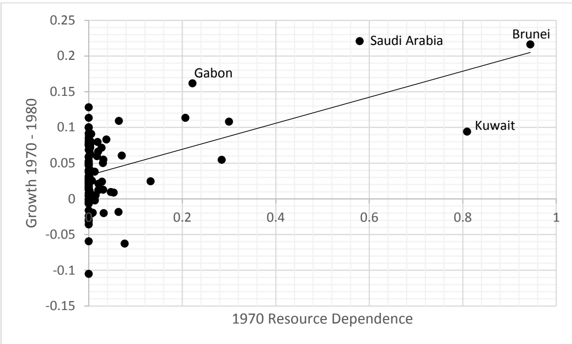
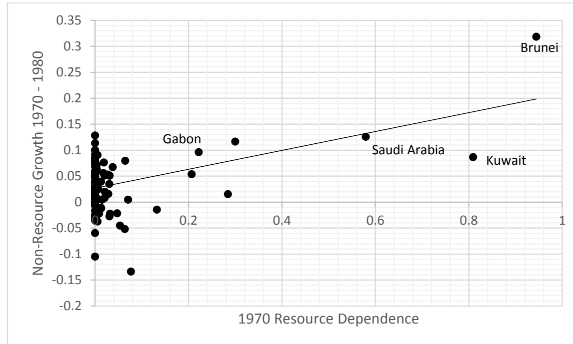
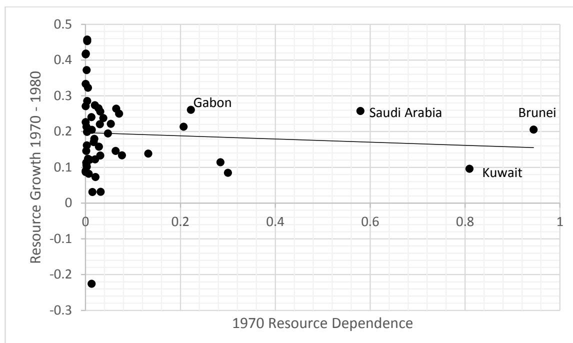
Figure 1: Plots of Total and Sectoral Growth and Resource Dependence, 1970 - 1980



(a) Growth and Res. Dep.

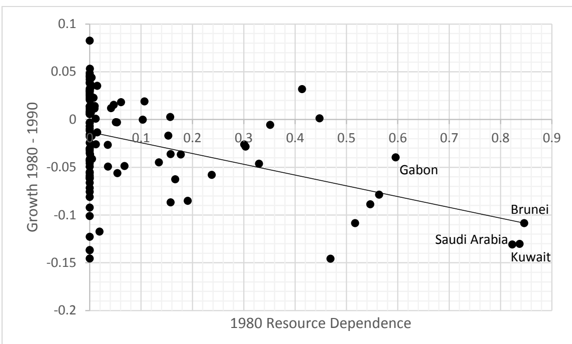


(b) Non Res. Growth and Res. Dep.

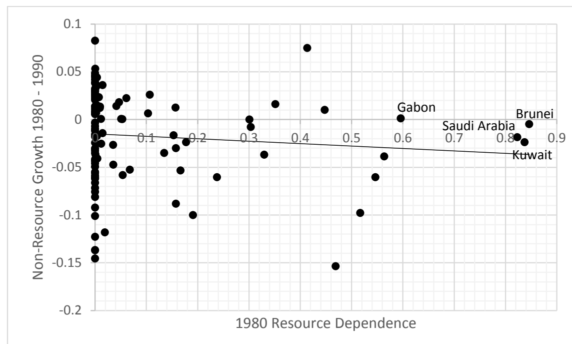


(c) Res. Growth and Res. Dep.

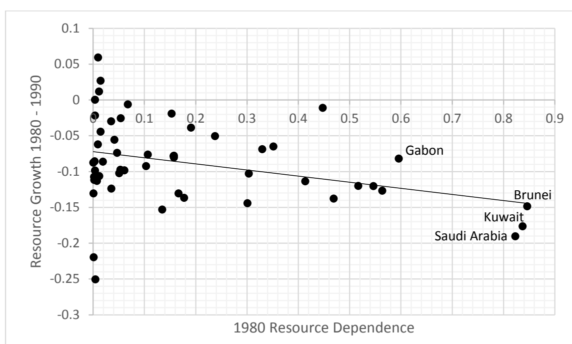
Figure 2: Plots of Total and Sectoral Growth and Resource Dependence, 1980 - 1990



(a) Growth and Res. Dep.

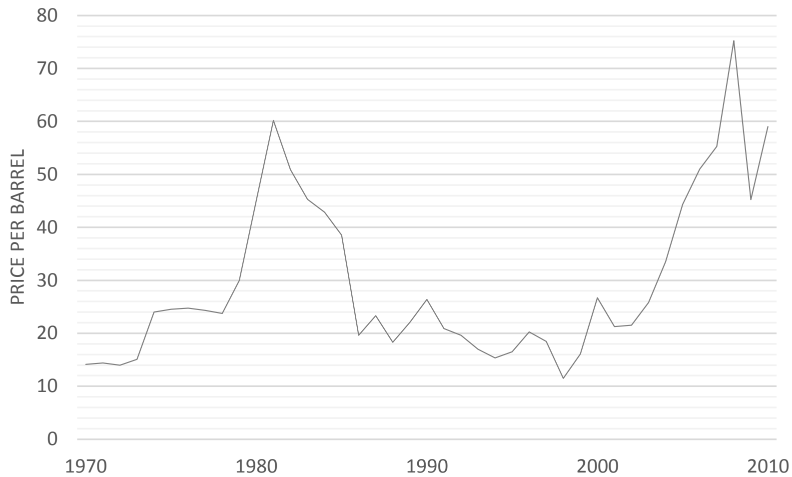


(b) Non Res. Growth and Res. Dep.



(c) Res. Growth and Res. Dep.

Figure 3: Real Oil Prices 1970-2010



Note: Oil prices reflect real domestic crude oil first purchase prices, where 2000 is the base year. Price data was collected from the Energy Information Administration and is available at: eia.gov/petroleum/.

Figure 4: Real Commodity Price Indices 1960-2000

Note: Commodity price indices were collected from the World Bank, Global Economic Monitor database. Prices are real and the base year is 2010.

Table 1: The Data Set

Africa	Americas	Europe	Middle East Cont'd
Angola	Bahamas	Albania	Saudi Arabia
Botswana	Barbados	Austria	Syria
Burkina Faso	Cuba	Bosnia	U.A.E
Burundi	Dominican Republic	Bulgaria	North America
Central African Rep.	Haiti	Cyprus	Canada
Comoros	Jamaica	Czech Republic	United States
Congo, Dem. Rep.	Trinidad and Tobago	Estonia	Oceania
Egypt	Asia	Finland	Australia
Eritrea	Afghanistan	France	Fiji
Ethiopia	Armenia	Germany	New Zealand
Gabon	Bhutan	Hungary	Solomon Islands
Gambia	Brunei	Iceland	South America
Guinea	Cambodia	Italy	Argentina
Guinea-Bissau	China	Latvia	Bolivia
Kenya	India	Luxembourg	Brazil
Lesotho	Indonesia	Macedonia	Chile
Liberia	Japan	Malta	Colombia
Madagascar	Laos	Moldova	Ecuador
Malawi	Malaysia	Netherlands	Guyana
Mali	Maldives	Poland	Paraguay
Mauritius	Nepal	Portugal	Peru
Morocco	Pakistan	Romania	Uruguay
Namibia	Singapore	Spain	Venezuela
Nigeria	Sri Lanka	Turkey	
Niger	Central America	United Kingdom	
Sierra Leone	Costa Rica	Middle East	
Swaziland	El Salvador	Bahrain	
Togo	Honduras	Iran	
Tunisia	Mexico	Israel	
Uganda	Nicaragua	Kuwait	
Zambia	Panama	Lebanon	
Zimbabwe			

Table 2: Estimations of Equation 1

Independent Variable: Resource Dependence at Start of Growth Period Dependent Variable: Average Annual Growth in Per Capita GDP, $N = 111$.					
Growth Period	b_0 (Std. Err.)	b_1 (Std. Err.)	$\bar{g}^R$	$\bar{g}^M$	Δ Oil Price
1970-1980	.039***	.182***	.1744	.0304	.116
	(.006)	(.029)			
1970-1990	.008**	.0196	.0196	.0067	.031
	(.003)	(.023)			
1970-2000	.0038	.0189	.0173	.0027	.021
	(.003)	(.019)			
1970-2010	.016***	.0155	.0230	.0158	.035
	(.002)	(.015)			
1980-1990	-.013***	-.113***	-.1133	-.0163	-.053
	(.005)	(.023)			
1980-2000	-.009**	-.049***	-.0573	-.0107	-.026
	(.004)	(.017)			
1980-2010	.011***	-.025**	-.0227	.0108	.008
	(.003)	(.013)			
1990-2000	-.004	.0061	.0011	-.0049	.0012
	(.005)	(.034)			
1990-2010	.024***	.0214	.0229	.0247	.040
	(.003)	(.019)			
2000-2010	.051***	.046**	.0513	.0533	.079
	(.004)	(.021)			

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Δ denotes the average annual change in the real, first purchase price of crude oil, where the base year is 2000. The independent variable is resource dependence at the beginning of the corresponding growth period, $r_{i,t}$. For example, the first row gives b_0 and b_1 from the estimation of equation (1) for the growth period 1970-1980. $\bar{g}^R$ and $\bar{g}^M$ are international average resource and non-resource sector growth rates for the corresponding growth period.

Table 3: Sector-Specific Growth Regressions

Independent Variable: Resource Dependence at Start of Growth Period			
Dependent Variable:	Resource Growth	Non-Resource Growth	
Growth Period	Coeff. on Res. Dep. (Std. Err.)	Coeff. on Res. Dep. (Std. Err.)	Δ Oil Price
1970-1980	-.044	.181***	.116
	(.018)	(.088)	
1970-1990	-.076	.083***	.031
	(.011)	(.054)	
1970-2000	-.037	.053**	.021
	(.008)	(.042)	
1970-2010	-.031	.045***	.035
	(.006)	(.030)	
1980-1990	-.085*	-.025	-.053
	(.009)	(.033)	
1980-2000	-.035	-.018	-.026
	(.007)	(.026)	
1980-2010	-.023	.0017	.008
	(.006)	(.022)	
1990-2000	.0219	-.032	.001
	(.008)	(.040)	
1990-2010	.011	.019	.040
	(.008)	(.042)	
2000-2010	.017	.082***	.079
	(.016)	(.065)	
N		52	111

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Resource (Non-Resource) Growth is the average annual growth rate of resource (non-resource) output per capita over the respective time period. Δ denotes average annual changes in the real price of oil, where the base year is 2000.

Table 4: Service and Manufacturing Growth Regressions

Independent Variable:	Resource Dependence at Start of Growth Period		
Dependent Variable:	Manufacturing Growth	Service Growth	
Growth Period	Coeff. on Res. Dep. (Std. Err.)N	Coeff. on Res. Dep. (Std. Err.)N	Δ Oil Price
1970-1980	.185***	.195***	.116
	(.040)60	(.030)85	
1970-1990	.112***	.082***	.031
	(.029)61	(.025)86	
1970-2000	.082***	.059***	.021
	(.024)62	(.021)84	
1970-2010	.0526	.023	.035
	(.043)53	(.032)74	
1980-1990	-.0314	-.040	-.053
	(.040)60	(.026)105	
1980-2000	-.002	-.019	-.026
	(.023)87	(.020)102	
1980-2010	-.0006	-.028*	.008
	(.019)74	(.0155)88	
1990-2000	-.038	-.027	.001
	(.043)119	(.034)139	
1990-2010	.023	-.005	.040
	(.026)101	(.021)122	
2000-2010	.061***	.035**	.079
	(.019)125	(.017)130	

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Manufacturing (Service) Growth is the average annual growth rate of Manufacturing (service) output per capita over the respective growth period. Δ denotes average annual changes in the real price of oil, where the base year is 2000.

Table 5: PPP Sector Growth Regressions

Independent Variable: Resource Dependence at Start of Growth Period			
Dependent Variable:	Resource Growth	Non-Resource Growth	
Growth Period	Coeff. on Res. Dep. (Std. Err.)	Coeff. on Res. Dep. (Std. Err.)	Δ Oil Price
1970-1980	-.096	.141***	.116
	(.088)	(.042)	
1970-1990	-.101*	.059**	.031
	(.055)	(.026)	
1970-2000	-.058	0.0282	.021
	(.043)	(.022)	
1970-2010	-.043	.029*	.035
	(.0331)	(.016)	
1980-1990	-.073**	-.028	-.053
	(.036)	(.028)	
1980-2000	-.032	-.030	-.026
	(.028)	(.020)	
1980-2010	-.022	-.008	.008
	(.023)	(.013)	
1990-2000	.031	-.055	.001
	(.046)	(.038)	
1990-2010	.005	-.0008	.040
	(.044)	(.019)	
2000-2010	-.0008	.064***	.079
	(.066)	(.017)	
N	52	111	

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Resource (Non-Resource) Growth is the average annual growth rate of resource (non-resource) output per capita over the respective time period. Δ denotes average annual changes in the real price of oil, where the base year is 2000.

Table 6: Results after controlling for resource sector growth, à la Davis (2011)

Dependent Variable: Average Annual Growth in Per Capita GDP, $N = 111$.			
Growth period	Coeff. on Res Dep. (Std. Err.)	Coeff. on Res. Growth (Std. Err.)	Δ Oil Price
1970-1980	-0.078	1.505***	.116
	(.079)	(.429)	
1970-1990	0.011	1.204**	.031
	(.023)	(.585)	
1970-2000	-0.0008	1.429	.021
	(.026)	(1.277)	
1970-2010	-0.023	2.087*	.035
	(.026)	(1.199)	
1980-1990	-0.008	.772*	-.053
	(.066)	(.459)	
1980-2000	-0.044	0.087	-.026
	(.087)	(.674)	
1980-2010	-0.0006	.881*	.008
	(.0189)	(.499)	
1990-2000	0.0005	1.204	.001
	(.034)	(1.042)	
1990-2010	-0.010	1.272**	.040
	(.024)	(.609)	
2000-2010	-0.032	1.171***	.079
	(.031)	(.350)	

Note. ***, **, * corresponds to 1%, 5% and 10% significance, respectively. Δ denotes average annual changes in the real price of oil, where the base year is 2000.