DEPARTMENT OF ECONOMICS AND FINANCE

SCHOOL OF BUSINESS AND ECONOMICS

UNIVERSITY OF CANTERBURY

CHRISTCHURCH, NEW ZEALAND

An Investigation of the Resource Curse in Indonesia

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WORKING PAPER

No. 11/2018

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September 2018

Abstract: We investigate the effect of resource dependence on district level income in a rare within-country study for Indonesia, one of the largest resource producing countries in Asia. We follow 390 districts between 2006 and 2015, consider four alternative measures of resouce dependence, and instrument for the potential endogeneity of each using historical measures of oil, gas and coal reserve locations, and changes in the physical production of each resource. Using annual fixed effects and first differenced regressions with and without various instruments, we find no evidence of a "resource curse". Instead, we find robust evidence across all models that dependence as measured by mining's share of output is positively associated with district real per capita income. We find a similar positive relationship between dependence as measured by the share of district government revenues from oil and gas or mining overall, and income in our most credible specifications with instruments. For example, a standard deviation increase in change in district government dependence on oil/gas revenues increases real per capita income by 16 percent over a nine year period.

Keywords: Resource dependence, resource abundance, mining, oil, gas, coal, economic growth, decentralization.

JEL Classifications: Q32, Q33, Q38, O47

Acknowledgements: We wish to thank Ralph Bayer, Tom Coupe, Andrea Menclova, Bob Reed, and session participants from the 2018 New Zealand Association of Economists annual meeting in Auckland for their comments on the paper. We especially thank Aditya Saputra and Adi Ramadhani, for their assistance in mapping from historical resource locations to modern districts. Finally, we gratefully acknowledge scholarship funding for this research from the Indonesia Endowment Fund for Education (LPDP) and Indonesian Ministry of Finance, as well as conference funding from the College of Business and Law of the University of Canterbury.

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1 Introduction

Until the late 1980's, economists generally argued or assumed that a country's endowment of natural resources benefitted its economic performance. Rostow (1959) argued that such endowments played a crucial role in a country's "take-off" or transition from traditional society based on a primary sector, to a more industrialized society with high consumption. Similarly, Douglas North stressed the significance of natural resource stocks as a driving component of a society's long-term output (North, 1982).

By the early 1990's, however, this positive view of resources in development faced an empirical challenge. Many resource abundant nations, located primarily in Africa, the Middle East, and Latin America, have tended to have low income levels, unstable growth, and generally worse performance on broader development indicators when compared to resource-scarce countries elsewhere. Auty (1994) was the first to label this counter-intuitive result a "resource curse". This term generally became defined as the negative impact of natural resource wealth on economic growth or on broader indicators of social development and governance (Humphreys, Sachs, and Stiglitz (2007).

Sachs and Warner (1995, 1999) conducted the first empirical tests of Auty's "resource curse," using a large pooled cross section, between-country study over twenty years (1970-1989) to test the relationship between dependence of exports on natural resources and growth in income. The negative association found seemed to confirm Auty's resource curse, and has sparked continuous attention ever since from academics and practitioners. There have followed hundreds of studies testing the relationship between natural resources and economic growth. The size of the literature is indicated by the number of survey articles (Frankel (2010); van der Ploeg (2011); Aragon, Chuhan-Pole and Land (2015); James (2015); Cust & Poelhekke (2015b); Papyrakis (2016); Van der Ploeg and Poelhekke (2016); Badeeb, Lean, & Clark, (2017)).

Many studies have confirmed a negative and significant effect of natural resources on economic growth. Gylfason (2001) uses data from 85 countries between 1965-1998 and finds that natural resource "abundance" (the share of each nations's natural capital over national wealth) is negatively associated with its growth in per capita GDP. Gylfason finds similar negative results using other resource intensity measures, such as the share of the primary sector in each nation's total employment. Others have found similar negative evidence (Stijns (2000), Papyrakis and Gerlagh (2004), Mehlum and Torvik (2006)). Papyrakis and Gerlagh

(2004) in particular find that natural resources specifically reduce growth indirectly, through their effects on intermediate variables such as increased corruption, lowered incentives for investment, reduced openness, worsened terms of trade, and weakened demand side incentives for schooling.

Indeed, various potential causal mechanisms have been suggested for a negative overall effect of resource abundance or dependence and growth. The first was the "Dutch Disease"[1], where booms in resource production and export cause currency appreciation that crowds out the performance of tradable non-resource sectors like manufacturing that may have greater spillovers for growth in the long run (Sachs and Warner (1995), Frankel (2010)). Other proposed mechanisms are that natural resource commodities are especially prone to damaging price volatility, or that the low-skill labour required for their production crowds out human capital accumulation by reducing the incentives for young people to remain in school (Gylfason (2001), Gylfason and Zoega (2006), Gylfason, Herbertsson and Zoega (1999)). Another is that resource dependence weakens the quality of a country's institutions by providing governments with concentrated sources of revenue outside income taxes, thus lessening their need for democratic accountability or openness to demands for reform (Ross (2001) and Isham, et al. (2005), Bulte, Damania, and Deacon (2005)). Another related mechanism is that the quality of public spending from resource windfall revenues is poorer than that from non resource revenues, being focussed more on current consumption and less on investment (Cust and Poelhekke (2015a) and Aragon, Chuhan-Pole, and Land (2015)).

Notwithstanding plausible theories for a resource curse, many other empirical researchers have found instead a positive association between countries' resource abundance or dependence and economic outcomes, and have expressed skepticism about the original results of Sachs and Warner. Brunnschweiler and Bulte (2008), for example, find no significant link between resource dependence (the share of mineral exports in GDP averaged between 1970-1989) and growth, and find a positive association between resource abundance (subsoil wealth) and growth. Alexeev & Conrad (2016) find positive effects on per capita GDP of both resource dependence (value of oil production over GDP) and of resource abundance (estimated oil reserves). Alexeev and Conrad (2011) similarly find positive effects of oil resources on per capita GDP for the transition economies of formerly socialist countries.

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[1] Initially, this label came from the discovery of natural gas near the town of Groningen in 1956, which raised the real exchange rate of the Dutch Guilder.

Most empirical resource curse investigations have followed Sachs and Warner (1995) in using between country comparisons, often taking care to include low or middle-income countries (Gylfason (2001), Mehlum, Moene, and Torvik (2006), Papyrakis and Gerlagh (2004)). Some researches have moved from pooled cross section to country fixed effects to control for stable, unobserved country-level characteristics that affect growth (e.g. Torvik (2009); Lederman & Maloney (2003)), and among these, some have still found a resource curse (Collier and Goderis 2009).

Some survey and individual resource curse studies have offered critical explanations for the literature's disparate findings. Cust and Poelhekke (2015a), van der Ploeg and Poelhekke (2016) and Badeeb, Lean, and Clark (2017) note that the negative association between between resource dependence in particular and growth has commonly been found in cross-country macro-level studies. These and other survey papers have blamed the literature's contradictory findings on weak robustness checks, unobserved heterogeneity across disparate countries that affects their economic outcomes, and the likely endogeneity of many commonly used resource dependence measures. For example, Brunschweiler and Bulte (2008) argue that Sachs and Warner's dependence measure (the ratio of resource exports over GDP) suffers from endogeneity, and instrument for it using averaged *historical openness* to trade in earlier periods, whereupon they find no evidence that higher dependence lowers economic growth. Ouoba (2016) similarly finds positive effects in between-country analysis once he instruments for a Sachs and Warner type dependence measure.

Endogeneity aside, survey papers have also suggested that within-country analysis may provide a more reliable test of the resource curse hypothesis because it provides greater control over unobserved heterogeneity in national factors that affect growth (Van der Ploeg and Poelhekke (2016), Papyrakis (2016), Aragona, Chuhan-Pole, and Land (2015), Cust and Poelhekke (2015a).

Of those resource curse studies that have looked within-country, many have indeed found a resource blessing rather than curse. In the case of Brazil, Caselli and Michaels (2013) find a positive impact of resource windfalls on local incomes, public goods, and public service delivery. In Australia, Hajkowicz, Heyenga, & Moffat (2011) find mining activities have a positive effect on per capita GDP and various quality of life indicators. The same conclusion is reached by Fan, Fang, & Park (2012) in the case of local level mining in China, by Weber (2012, 2014) for Western U.S. states, Aragón and Rud (2013) for Northern Peru, Libman

(2013) for Russia, and by McMahon and Moreira (2014) in a descriptive study of five resource-rich mining countries (Chile, Ghana, Indonesia, Peru, and South Africa.)

Unfortunately, the move to within-country analysis has not resolved the 'resource curse' debate, as other within-country studies have found opposing results in line with the original findings of Sachs and Warner (1995). Papyrakis and Gerlagh (2007) examine United States counties in pooled cross section over time and find a negative association between resource dependence (the share of the primary sector in real gross state product (GSP)), and long-term growth in income. The authors finds this even in more homogenous sub-samples of counties. James & Aadland (2011) similarly find negative effects using United States counties. Douglas and Walker (2016) focus on coal dependence among Appalachian counties in the United States using a panel data set over four decades, and also find negative effects on growth. Guo, Zheng, and Song (2016) similarly find negative, albeit weak linkages between resource dependence and output using panel data at the provinvial level in China.

Surprisingly, while many resource curse studies have been carried out in the Middle East, Africa, Latin America and China, few have examined countries in Southeast Asia. Indonesia is the richest country in Southeast Asia in terms of natural resource endowments (oil, natural gas, coal, minerals, forest products, and agriculture) yet large enough that resource abundance and dependence vary dramatically across regions of the country.[2] While some prominent papers have included Indonesia as a sample country among others (e.g. Gylfason (2001), Gylfason and Zoega (2006), Brunnschweiller and Bulte (2008), Arezki and van der Ploeg (2011)), few have formally tested for a resource curse within the country.

In pioneering work within Indonesia, Komarulzaman and Alisjahbana (2006) analyze the effect of resource rents (from forestry, mining, oil and gas, or in total) on district level GDP, or Gross Regional Domestic Product (GRDP) in 2001, the first year of Indonesia's fiscal decentralisation. Komarulzaman and Alisjahbana find that while total rent (from all natural resources) has no significant effect on regional economic growth, mining rents in particular have a negative effect. Edwards (2016b) similarly investigates the effect of mining dependence (the share of all non-renewable resource output in GRDP) within Indonesia on several social development indicators in 2009. Edwards finds that mining dependence may

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[2] In 2016 Indonesia was the world's 7th largest producer of mineral fuels, 6th largest coal producer and 1st largest coal exporter (World Mining Data 2018; Indonesia, PwC, 2018; ICC, 2013; Brown, 2017). It is the 10th largest producer of natural gas (3rd in the Asia-Pacific region).

significantly reduce household investment in human capital (measured as education and health expenditures). It may also reduce education and health outcomes, measured as enrolment rates in senior secondary school, test scores, and births attended by a skilled health worker, respectively. However, similar to Komarulzaman and Alisjahbana (2006), Edwards does not use instrumental variables to address potential endogeneity in his resource dependence measure. In addition, both studies have relied on single year cross-section data, making their conclusions vulnerable to omitted variable bias.

Most relevant to our paper, Cust and Rusli (2016) have provided a valuable analysis of the effects of district government dependence on oil and gas revenues on level or change in district GRDP over the period 1999-2009. Cust and Rusli try to address the potential endogeneity of royalties using the instrument of total offshore oil production (within 0-4 miles of a district's coastline) in both level and change models. Far from a resource curse, Cust and Rusli instead find that oil and gas revenue windfalls boost local economic GRDP.

While Cust and Rusli's study provides the highest quality investigation to date of the harm or benefit of resource dependence within Indonesia, our current investigation contributes on several fronts. First, we start our analysis in 2005 rather than 1999, when the capacity of post-decentralisation Indonesian local districts to report accurate data had improved, and we extend analysis out to 2015. Second, we examine the effects of coal dependence as well as oil and gas, whether as share of local GRDP, or resource revenues as share of local government budget. Third, while repeating Cust and Rusli's use of physical output instruments, we also source other instruments related to historical resource abundance – a necessary precondition for resource dependence.

The rest of this paper proceeds as follows: Section 2 provides a brief history of natural resource development in Indonesia, and describes the country's decentralisation process between 2001 and 2004. Section 3 explains our data and empirical estimation strategies for estimating the effects of mining dependence on local income. Section 4 provides our results, while Section 5 concludes.

2 Indonesia's Natural Resource History

Indonesia is the third most populous country in the world after China and India. Within Southeast Asia, it is the largest in terms of land area, population (255,461,700), and gross domestic product.[3] The country has a long history of natural resource exploration. Many ventures were initiated by Dutch geologists, when the Netherlands colonized Indonesia on behalf of the Netherlands East Indies company. The Dutch geologist Jan Reerink surveyed and drilled for crude oil beginning in 1871 in what is now the Cirebon district of West Java Province. Though this and other early efforts were unsuccessful in extracting substantial amounts of oil, they left clues as to the location of oil deposits over West Java and others islands.[4]

In 1911, the company Royal Dutch (also known as *Bataafsche Petroleum Maatschappij* or B.P.M) found strong evidence of large deposits on several other islands, and secured concessions for roughly 44 oil fields. These succeeded in producing roughly 13 million barrels. The competitor *Nederlandsche Koloniale Petroleum Maatscappij* (N.K.P.M) then began exploration in 1912 though with more limited production. By 1930, the main oil fields on Kalimantan Island contributed roughly 68 per cent of Indonesia's total oil production.

Caltex, a merger between a subsidiary of Standard Oil of California and the Texas Corporation, started operating in Indonesia in 1936. Caltex conducted much succesful exploration and oil production. By 1940 its wells in the Minas Field of Central Sumatra were contributing about 61.5 million barrels annually (Bee, 1982). Oil production fluctuated and fell dramatically with the Japanese invasion and Second World War. Indonesia was targeted by Japan for occupation in large part because of its vast deposits of natural resources, with Dutch concessions taken over by the Japanese. When Japan surrendered to the United States in 1945, the young Indonesian leader Soekarno proclaimed Indonesia's independence.

Under Soekarno Indonesia nationalized the oil and natural gas sectors. The Indonesia Oil Company took what had been left by Royal Dutch, Shell, and other companies. Under the Indonesia Oil Company, production rose from 63 million barrels in 1951 to about 177 million barrels by 1965. However, a coup attempt by the Communist Party in 1965 destabilized the government, with Soekarno accused of protecting communist ideology. His government collapsed, and Major General Soeharto, with the support of the military, became the country's new leader in 1966, and ruled Indonesia until 1998. Soeharto's government, while authoritarian, encouraged foreign investment.

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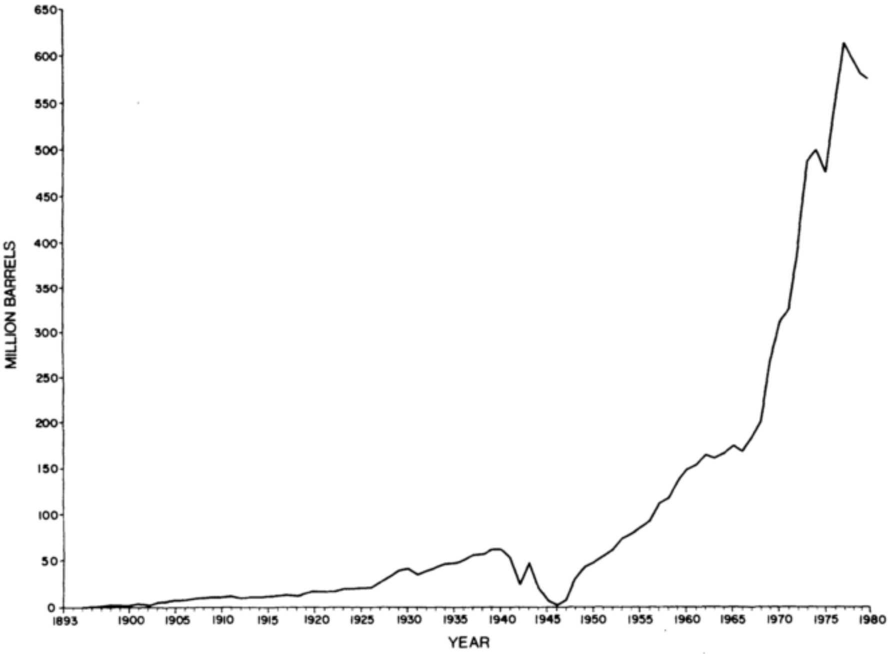
[3] From the Association of Southeast Asian Nations (ASEAN) Key Selected Indicators data base as announced in August 2016.

[4] The history summarized here is heavily indebted to Bee (1982).

Figure 1. Historical Crude Oil Production in Indonesia, 1895-1980



Source: Bee (1982), page 15.

The renamed National Oil Company (PERTAMINA) attracted many foreign oil companies to join under "production sharing contracts" to explore and produce crude oil. As a result, many oil discoveries took place beginning in 1968, and resulted in several offshore oil fields in North-West Java and East Kalimantan, and onshore fields in Central Sumatra. Crude oil production thus increased sharply in Indonesia between 1960-1980 (see Figure 1). While much less prominent than oil, natural gas extraction also climbed rapidly in Indonesia, starting in 1976. Fields in the Aceh Utara and Kutai districts contributed to commercializing Indonesia's natural gas production for export (Bee, 1982).

While crude oil has been the dominant non-renewable resource exploited in Indonesia, coal mining also has a long history. In the 1850's, geologists of the Dutch colonial government struggled to find coal abundant areas, with little attention paid thereafter. More than a century later, coal exploration expanded quickly during Soeharto's rule in the late 1970's, driven by the falling price of oil. Following this exploration, coal was found in West Sumatra, East and South Kalimantan Provinces between 1973-1980, under the supervision of the state owned mining company *PN Tambang Batu Bara*. Coal extraction rapidly expanded between 1981-1988. This growth was again assisted by the central government inviting the foreign companies who had found the deposit to sign Coal Contracts of Work (CCoW). Much of the country's subsequent coal production has been sourced from these locations, with those CCoW signed between 1981 and 1990 accounting for more than 50 per cent of total coal output in 2015 ((Leeuwen (1994) and Friederich and van Leeuwen (2017)).[5]

Crucially for our subsequent estimation strategy, we argue that the historical locations of oil and gas fields and coal deposits in Indonesia established by the early 1980's have become the main areas of mineral extraction in the time covered by our study.

Moving to the more recent development of Indonesia's natural resources, Figure 2 shows the production of all resource types from 1973-2012. Together, oil and coal have comprised more than 60 per cent of total production. From the late 1990's onward oil has declined relative to coal, usually attributed to falling world oil prices from excess supply and weakened demand from European and Asian countries and rising natural gas use. In contrast, world coal prices have risen, driven by the high demand in China, India, and in some parts of Europe. Oil still remains, however, the largest contributor to mining production. In contrast to oil and coal, natural gas production has remained modest over the 1976-2012 period, rising only in 2009 after the central launched a conversion program for consumers away from kerosene. Note finally from Figure 2 that production of the remaining types of resource is relatively small.

2.1 Decentralisation and Resource Rent Allocation

Indonesia has undergone major changes in governance from the late 1990's to early 2000's. The authoritarian government under Soeharto, while providing political stability and encouraging foreign investment, hampered democracy and provided much scope for rent-seeking among those with ties to the government. Indonesia's economy performed particularly badly following the Asian Financial Crisis in 1997, resulting in Soeharto stepping down and paving the way for a change from a highly centralized to a highly decentralized and democratically accountable system of provincial and district level governance.

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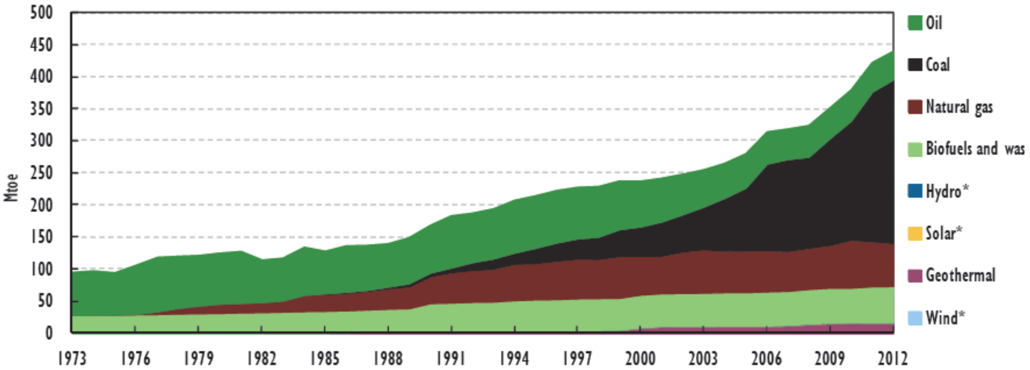
[5] There were eleven foreign companies under contract with the Indonesia government under PN Tambang: Arutmin, Utah Indonesia, Agip, Kaltim Prima Cola, Adaro, Kideco, Berau, Chung Hua, Allied Indo Coal, Multi Harapan Utama, Tanito Harum, and Indominco Mandiri (Friederich and Leeuwen, 2017).

Figure 2. Production of mining in Indonesia, specified by types, 1973-2012



Source: IEA, Indonesia Energy Policies, 2015 (http://www.iea.org/publications/freepublications/publication/energy-policies-beyond-iea-countries---indonesia-2015.html)

Decentralisation began with the implementation of the autonomy law (Law 21/1999) and revenue sharing law (Law 25/1999). Local citizens in each district would elect their regional leaders for both executive and legislative positions, while conversely, the administrative and political processes and regulatory framework would become homogenized. Under revenue sharing, resource revenues were to be first collected by the central government, and then redistributed to districts such that more resource productive districts receive a larger share of revenues. In particular, a share of revenues from onshore oil and gas wells would be allocated to the district containing the wellhead. Revenue from offshore wells would go to the district with the closest coastline if within 4 miles, to the province if within 4-12 miles, and remain with the central government beyond that. For coal and other minerals, district revenues would be calculated based on the total area in which coal companies had a license to operate, as well as by production volumes and sales price. Coal revenues would thus return to districts based on fixed land rents and per unit royalties. One implication of the overall transfer rules between the central and provincial governments is that a given district's receipt of resource revenues will increase with the resource wealth of the other districts in its province.[6] At the extreme, a district without resource production would receive no windfall revenues if all other

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[6] Under decentralisation provinces do not have much administrative authority beyond their role in distributing resources upwards to the central government, or downwards to district.

Table 1 Percentage of Point Source Natural Resources Revenue Sharing Allocation

No	**Type of Natural Resources**	**The Law of 33/2004**		
		Central Government (%)	**Province Government (%)**	**District Government (%)**
1	Oil	84.5	3.1	6.2
2	Natural gas	69.5	6.1	12.2
3	Coal and other minerals (Land rents)	20	16	64
4	Coal and other minerals (Royalties)	20	16	32

Source: DJPK Depkeu, Ministry of Finance, Republic of Indonesia (Type of natural resources is restricted only for "point-source" resources type)

districts in its province also extract no resources. Table 1 summarises the allocation rules.

By 2001 most of the country's 336 districts applied to be responsible for public service delivery, and to receive enabling financing from the central government. A revised revenue sharing Law 33/2004 replaced Law 25/1999 in 2004. Decentralisation was fully implemented by 2005, and natural resource income became an important source of finance for some districts (Aden (2001)).

3 Data and Empirical Estimation Strategy

We focus on the effects of resource dependence (a flow) rather than abundance (a stock) for two reasons. First, unlike dependence, abundance measures such as estimated oil and coal deposits are not generally available at the district level, particularly over time. Second, most previous empirical studies have tended to use dependence measures. We begin with a measure of mining dependence (which includes coal, oil, gas, and all minerals, including quarrying) similar to what has been employed by within-country papers such as Douglas and Walker (2016) and Papyrakis and Gerlagh (2007) for the United States, or the Indonesian study by Edwards (2016b). Edwards employs mining and quarrying's share of total GRDP for each district in Indonesia using cross-sectional data, in 2009. We use this as our first resource dependence measure in Indonesia, for the years 2005 to 2015.

However, some within-country studies have instead tried to capture resource dependence as the reliance of governments on resource rents or royalties, particularly in studies of large decentralised systems such as Brazil where central governments transfer revenues from extraction back to local districts based on "producer origin" (Casselli and Michaels (2013), Bjorvatn, et al. (2012), Cust and Rusli (2014, 2016) and Douglas and Walker (2016).[7] We therefore try three additional measures, namely district government dependence on mining revenues (MINREV) from oil, gas and coal, or just from oil and gas (OILGASREV), or just from coal (COALREV). These data are obtained from the Indonesian Ministry of Finance and the Audit Investigation Board (BPK) from 2005 to 2015.[8]

Most of the remaining data required for this study come from the "Indonesia Data for Policy and Economic Research" or INDODAPOER data base published by the World Bank.[9] INDODAPOER provides more than 300 indicators at district level, gathered from official government sources such as Susenas (the National Economic Survey), the Indonesia Statistical National Agency (BPS), and the Ministry of Finance.[10] Unfortunately, most district level observations are missing for most variables prior to decentralisation (1976-2003). Fewer district level observations are missing from 2003 to 2005, and virtually none thereafter. To populate missing observations from 2003 onward, I use the statistical yearbook published by the BPS.[11] A list of variables and their definitions is presented in Appendix 1.

We ultimately elected to exclude 2003 and 2004 because of evidence of some unevenness in the quality of the district level data in these years of political transition and revisions to the planned revenue sharing Law 33/2004 that were implemented in 2005. In short, only by 2005 were both elections and revenue sharing effectively implemented by all districts, and missing observations cease.

An obstacle to following districts since 2005 has been the official government policy since 2001 of "proliferation" (*pemekaran)* of districts with the aim of making local

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[7] Komarulzaman & Alisjahbana (2006) and Loayza & Rigolini (2016) also use a similar measure of resource dependence. Cust & Poelhekke (2015a) discuss the importance of observing the effects of revenue based on natural resources under fiscally decentralized systems.

[8] The Audit Board publications can be downloaded from http://www.bpk.go.id/lkpp , while the Ministry of Finance data from http://www.djpk.depkeu.go.id/?page_id=307.

[9] The datasets can be downloaded from http://data.worldbank.org/data-catalog/indonesia-database-for-policy-and-economic-research.

[10] These include rural districts (*kabupaten*) and urban districts (*kota*/municipalities).

[11] This can be downloaded from https://bps.go.id/index.php/Publikasi .

government closer to the people in the hopes of improving public service delivery. According to the Ministry of Home Affairs, the number of districts in Indonesia has risen from 336 districts in 2001, to 477 in 2010, to 512 in 2015. To facilitate longitudinal analysis, we merge "child" districts back into their "parent" districts using the annual population of each "child" to create appropriate weights. Since most districts existing in 2015 were identifiable from parent districts in 2003, we use this as our benchmark year.[12] This results in 390 consolidated districts for each year after 2003, creating a balanced panel.

3.1 Estimation Strategy

We use three approaches to estimate the effects of resource dependence on output: annual district fixed effects, a first-difference regression between 2006 and 2015, and a similar first difference regression with instruments for our resource dependence measures.

Fixed Effects (FE) has the advantage of controlling for district-specific effects on growth caused by unobserved heterogeneity between districts.

$$Ln(GRDP)_{i,t} = \alpha_{i,t} + RD_{i,t}\beta + X_{i,t}\,\beta + \mu_i + \delta_t + \varepsilon_{it.} \qquad (1)$$

Here GRDP is per capita Gross Regional Domestic Product (real prices in 2000) of district i at time t, where i = (1, ..., 390), and time t = (2005,….,2015). The natural log of GRDP is used as is common in standard growth models, in order to mitigate problems such as potential skewness or stationarity that often occurs in annual income panel data (see Wooldridge, 2016, and resource curse studies by Mamun, et al. (2017), Bjorvatn, et al. (2012), Sarmidi, et al. (2014), and Cust and Rusli (2014, 2016)). RD refers to the resource dependence of district i in year t, μ_i is the district fixed effect, and $\delta_t$is a year dummy to control for events common to all districts at a point in time, such as changes in commodity prices, business cycle fluctuations, or economic crises. The error term, ε_{it} is assumed to be independently and identically distributed (i.i.d).

We try four alternative measures of our key $RD_{i,t}$ variable as described previously: the share of mining in district real GRDP (MINDEP), the share of the district government's

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[12] The 2003 list of districts comes from the Ministry of Home Affairs. We exclude the regions of Jakarta (Central Jakarta, West Jakarta, East Jakarta, South Jakarta, Kepulauan Seribu) and Tanjung Pinang district. Jakarta is excluded because it is not defined as a district under decentralisation law. The latter district is omitted because of lack of data availability over time.

revenues that come from combined oil, gas and coal (MINREV), or from oil and gas alone (OILGASREV), or coal alone (COALREV).

Finally in (1), $X_{i,t}$ is a matrix comprising other determinants of GRDP per capita, such as the total number of annual earthquake events at the district level, the labour force participation rate, and the proportion of households with access to electricity. The latter two variables range from 0-1. Some standard control variables from cross-country growth studies, such as openness to trade (export activities) or private investment are unfortunately not available within country.

We next try a first difference (FD) model because it allows resource dependence to have long term effects on GDP (Barro (1991)). FD models are similar to FE models in controlling for unobserved heterogeneity in districts that affects growth (Wooldridge, 2016). Aside from being widely used in the resource curse literature, FD also provides a "bridging" model for attempts to address potential endogeneity of resource dependence measures using cross sectional instruments. We take a 10 year difference, $t_{2015} - t_{2006}$ and retain 2005 as a baseline year to control for initial district GRDP as commonly implemented in growth and resource curse studies (Sachs and Warner, 1995; Douglas and Walker, 2016; Edwards, 2016b). The inclusion of initial GRDP tests for convergence in income between districts as suggested in traditional growth theory (Barro (1991) and Temple (1999)). A negative coefficient would imply that poorer districts have subsequently had higher growth than richer districts.

Our first difference model is:

$$\Delta Ln(GRDP_i) = \alpha_i + \Delta RD_i\beta + \Delta X'_i\,\sigma + \Delta\varepsilon_{it}, \tag{2}$$

where $\Delta Ln(GRDP_i) = ln(GRDP_{i,2015}) - ln(GRDP_{i,2006})$ and ΔRD_i, is the nine year change in the level of resource dependence in district *i*. The $\Delta X'_i$ stands for changes in some control variables like labour force participation rate, but we also include the initial level of population in 2005 (in logs) and the total number of earthquake events over the difference period. We include initial population to test for potential pro-growth effects of economies of scale. We now also include additional level dummies that would wash out in FE: urban status (DURBAN), and location on Java Island (DJAVA). Historically, Indonesian investment and infrastructure development has been concentrated in Java.

We finally use a first difference model with instrumental variables. Several key resource curse papers criticize the commonly used measures of resource dependence as being very likely to suffer from endogeneity. Dependence measures are commonly constructed as a ratio, where the denominator captures overall economic activity in a way that may be related to the dependent variable. We therefore look for valid exogenous instruments for our four resource dependence measures. We did not use instruments in our annual FE model because our main instrument is time invariant.

To be valid, an instrument must be correlated with the potentially endogenous regressor in the first-stage regression, and not correlated with the error term. We follow the strategies of Edwards (2016a) in an international cross-country context, Caselli and Michaels (2013) for Brazil, and Cust and Rusli (2016) for Indonesia of constructing measures of past resource abundance. For example, Edwards (2016a) uses 1971 estimated national fuel reserves, Caselli and Michaels use Brazil's past oil output, and Cust and Rusli use change in national oil and gas output between 1999 and 2009 for Indonesia. All of these approaches seem likely to generate instruments that are correlated with subsequent resource dependence, because past abundance or rises in physical production seem logical pre-conditions for greater resource dependence. We thus instrument for our various ΔRD_i measures using each district's historical level of abundance of the relevant resources, or RA_{1970s}.

Our historical abundance level instruments are produced using original historical maps released by Bee (1982) and Leeuwen (1994, 2017). ArcGIS software was used to match geographic coordinates of oil/gas fields or coal exploration agreement areas according to the Bee, Leeuwen, and Frederich and Leeuwen maps with specific district boundaries as of 2003. This resulted in new maps which we illustrate in Appendices 2-3. We try both continous and binary versions. For binary versions, we classify districts as oil or gas abundant if they had at least one proven major field as of the 1970's, and as coal abundant if at least 20 per cent of a district was covered by "first contract" agreements with coal companies as of the 1980's. By this time, knowledge of resource locations had accumulated based in part on exploration efforts by the Dutch when Indonesia was a colony. Yet this period also immediately preceeded a "golden era" of natural resource commercialization in Indonesia.[13]

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[13] One might argue that measurable resource abundance is not actually exogenous to income, since poorer regions might invest less in oil, coal or gas exploration. However, as we have described, historical exploration in Indonesia was funded centrally either by Dutch geologists, or the Indonesian central government in conjunction with multinational corporations.

For continous versions, for oil and gas we use the number of major or minor oil and gas fields in the 1970's.[14] For coal we divide "first contract" deposit areas by total district areas as shown in an original map by Leeuwen (1994) and Frederich and Leeuwen (2017). Table 2 summarizes our abundance based instruments as customised for each of our four resource dependence measures.

While levels of past abundance or extraction seems a logical pre-condition for dependence, it is less clear *ex ante* why they should be correlated with *change* in dependence. It is possible that for oil and gas, the considerable capital and risk bearing needed to ramp up extraction following succesful exploration could lead to a positive correlation. For coal, first contracts might only reveal the potential for viable coal deposits to be found, which would require time to confirm with geological sampling.[15] Nonetheless, in case of instrument weakness, we also try to construct a change form of an abundance instrument. This is difficult to do since it requires a reliable measure of resource reserves at district level over the two years 2006 and 2015. Since such data is not publicly available from the Indonesian government, we follow Caselli and Michaels (2013) and Cust and Rusli (2016) in using the change in physical oil and gas output. Data on oil and gas lifting are released by the Ministry of Energy and Mineral Resources (MEMR), who use them as a basis for district revenue redistribution. For coal, we use instead changes in combined land rents and royalties.

Taking our first resource measure (MINDEP) to illustrate, the first and second stage regressions are modelled as follows:

$$\Delta RD_i = \alpha_0 + \gamma RA_{1970s} + \gamma \Delta OIL_i + \gamma \Delta GAS_i + \gamma \Delta COAL_i + \Delta X'_i \beta_2 + \Delta \varepsilon_{it} \quad (3)$$

$$\Delta LnGRDP_i = \pi_0 + \pi_1 \Delta \widehat{RD}_i + \Delta X'_i \pi_2 + \Delta \varepsilon_{it} \quad (4)$$

We use all instruments together when using MINDEP or MINREV. For OILGASREV we drop levels of coal abundance and changes in coal revenues as instruments, while for COALREV we drop the corresponding instruments for oil and gas abundance and change in production. Our mapping of instruments is summarized in Table 2.

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[14] For coastal oil fields in particular, we only include oil and gas wells within 4 miles of the coastline, based on revenue sharing rules laid out under Law 33/2004.

[15] By comparing current maps of main extraction activities provided by the Ministry of Energy and Mineral Resources, it is clear that no dramatic shift has occured over the 2006-2015 period. Thus, there is no way for district governments to enjoy resource windfalls in 2015 without having had successfully proven deposits 30-40 years before.

Table 2 Instrument Summary

	Resource Dependence Measure	Instruments – Level		Instruments – Change
		Binary	Continous	
ΔRD_i	$\Delta\left(\frac{GRDP_{mining}}{GRDP}\right)$	- Oil + Natural Gas Abundance 1970’s - Coal Abundance 1980’s	- Oil + Natural Gas Abundance 1970’s - Coal Abundance 1980’s	- Change in oil production - Change in gas production - Change in coal rents+royalties
	$\Delta\left(\frac{GovRevenue_{mining}}{Total\ Revenues}\right)$	- Oil + Natural Gas Abundance 1970’s - Coal Abundance 1980’s	- Oil + Natural Gas Abundance 1970’s - Coal Abundance 1980’s	- Change in oil production - Change in gas production - Change in coal rents + royalties
	$\Delta\left(\frac{GovRevenue_{oil+gas}}{Total\ Revenues}\right)$	- Oil + Natural Gas Abundance 1970’s	- Oil + Natural Gas Abundance 1970’s	- Change in oil production - Change in gas production
	$\Delta\left(\frac{GovRevenue_{coal}}{Total\ Revenues}\right)$	- Coal Abundance 1980’s	- Coal Abundance 1980’s	- Change in coal rents + royalties

For all IV estimation we use two step feasible efficient Generalized Method of Moments (GMM2S) with robust standard errors rather than two stage least squares (2SLS) to address the potential presence of heteroskedasticity and produce more efficient estimates. We then perform validity tests for weakness and overidentification, given that the number of instruments exceeds the number of suspected endogenous regressors.

4 Empirical Results

Summary statistics for annual panel and first-difference data are shown in Tables 3 and 4, respectively. We have 4,290 observations for 390 districts in FE, and 390 observations in FD with or without instruments. Note the mean share of mining in total GRDP is about 9.0

per cent, while the mean share of mining revenue in district government budgets is about 5.3 per cent. From Table 4, for the country as a whole, dependence of GRDP on mining has been growing slightly, yet dependence of district government budgets on resource revenues has been declining.

To start with simple correlations, Figure 3 presents a scatterplot of each district's 11 year averaged dependence of GRDP on mining (MINDEP) against its real GRDP per capita. Already there appears to be a positive relationship, confirmed by a linear fitted trendline. Figure 4 shows a similar positive correlation between share of district government revenues from oil and gas and real GRDP per capita.

As a second illustration, we compare the real growth in GRDP per capita between the country's least and most dependent on mining in GRDP.[16] We find that more dependent districts grew by 8.2 percentage points more than less dependent districts between 2006 to 2015, which a simple t test finds to be a significant difference at the one per cent level. To see if this resource blessing persists with control for confounding factors, we proceed to regressions.

We begin with our FE results as reported in Table 5. The impact of the four dependence measures are presented in models (1) to (4), respectively. We find mining dependence (MINDEP) in model (1) is significantly positively associated with real GRDP per capita. In particular, a standard deviation increase in MINDEP (0.179) is associated with an increase in real district income per capita of (0.179*0.406 = 0.0727) 7.27 per cent, on average, all else equal. Oil and gas revenue dependence in model (2) has a positive sign, but is not significant. In contrast, coal resource revenue dependence in model (3) has a negative effect on GRDP per capita, albeit only significant at the 10% level. Not surprisingly given the opposing effects, the combined oil, gas and coal revenue dependence in model (4) has a coefficient near zero, and is not significant. At first glance, FE results may indicate that resource dependence in overall output is good for GRDP, while dependence in government budgets has either no effect, or possibly a negative effect if dependence is specifially on coal revenues. That is, the closest we come to finding a resource curse is with the narrow measure of district government budget dependence on coal revenues.

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[16] We rank the 390 districts by mining's share in its GRDP as averaged between 2006 and 2015, and then split these into two equal sized groups. The more mining-dependent districts grew 45.5 % over the nine years, while the less dependent grew 37.3%.

Table 3 Descriptive statistics for all districts/years pooled

Variable	Obs	Mean	Std. Dev.	Min	Max
Real GRDP per capita (in logs)	4290	4.139377	0.690165	1.951301	7.683826
Mining Dependence GRDP	4290	0.090965	0.179296	0	0.954621
Mining Revenue Dependence	4290	0.052757	0.123603	0	0.872433
Oil&gas revenue Dependence	4290	0.03799	0.106686	0	0.871858
Coal Revenue Dependence	4290	0.014772	0.044392	0	0.550445
Earthquake	4290	0.05990	0.25257	0	3
Labour force participation rate	4290	0.645012	0.095994	0.1949	0.988
Households with electricity	4290	0.874352	0.189802	0.0028	1

Looking at other control variables in Table 5, GRDP looks to be negatively associated with the frequency of earthquake events, though only at the 10 per cent level. Model (2) finds, for example, that one additional earthquake between 2005 and 2015 decreases real per capita GRDP by 0.0168 per cent. The labour force participation rate has a positive coefficient but is not significant, nor surprisingly is the proportion of households with access to electricity.

Overall, our FE results do not support the standard resource curse hypothesis, with a possible exception for local government dependence on coal mining revenues. These results are similar to those found by Cust and Rusli (2016) at the district level for oil and gas alone, but they do not address potential endogeneity of our dependence measures.

Moving to our FD models, with a direct measure of urban/rural status, we no longer use household access to electricity. Recall we also now include initial real GRDP per capita in 2005 (in logs) to control for initial economic conditions, and the size of initial district population in 2005 to test for gains to growth from economies of scale. Results are provided in Table 6, again by resource dependence meausure in columns (1), (2), (3) and (4). As with FE, we find a strong positive association between output dependence (model 1) and GRDP per capita. In particular, a standard deviation increase in the change in mining's share of local GRDP is associated with a (=0.142 * 0.738 = 0.105) 10.5 per cent increase in GRDP per capita. Yet also as with FE, the effects of government dependence on resource revenues is much less conclusive. Whether oil and gas revenue dependence in model (2), coal dependence

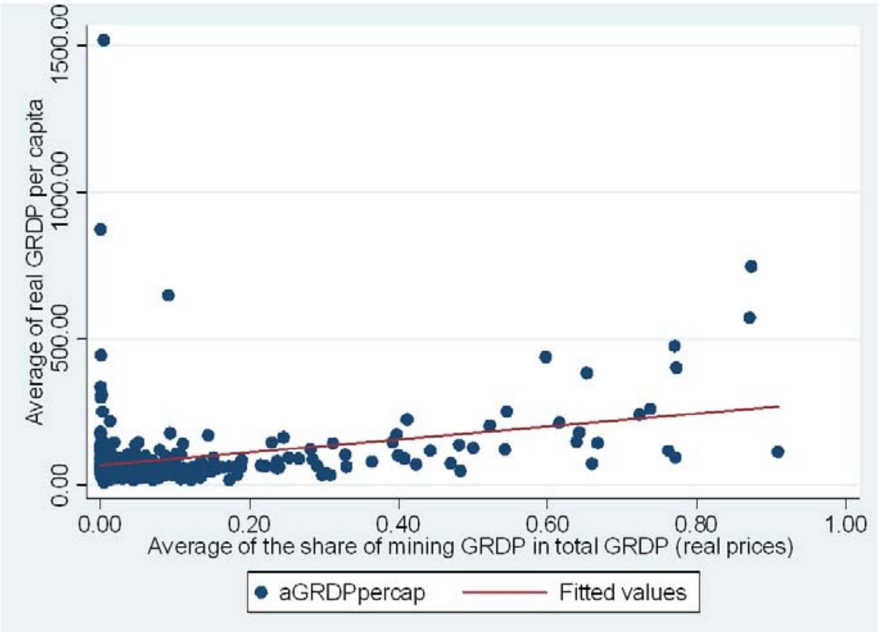
Table 4 Descriptive Statistics for First Difference Model

Variable	Obs	Mean	Std. Dev.	Min	Max
Δ Real GRDP per capita (in logs)	390	0.413809	0.344784	-0.85163	2.685206
ΔMining Dependence	390	0.011747	0.141974	-0.61372	0.795062
ΔMining Revenue	390	-0.01322	0.084406	-0.52328	0.255585
ΔOilgas Revenue	390	-0.02868	0.091328	-0.52781	0.224138
ΔCoal Revenue	390	0.015421	0.047512	-0.11861	0.358853
Earthquake	390	0.464103	0.936269	0	7
ΔLabour force partic.rate	390	0.067598	0.112044	-0.1906	0.4427
Population, 2005 (in logs)	390	12.72085	1.028841	9.450066	15.227
GRDP per capita, 2005 (in logs)	390	3.937389	0.703827	1.951301	7.683826
DURBAN	390	0.207692	0.406176	0	1
DJAVA	390	0.302564	0.459958	0	1
Instruments					
Oilgas_continous	390	0.153846	0.660138	0	7
Coal deposit_continous	390	3.660233	14.32723	0	94.2137
Oilgas_binary	390	0.058974	0.235879	0	1
Coal deposit_binary	390	0.066667	0.249764	0	1
Δoil production (thousand barrels)	390	-103.164	3805.166	-22751.3	64381.61
Δgas production (MMBTU)	390	267.5436	31094.97	-402891	378035.7
Δ coal production (IDR)	390	92.61852	508.369	-45.2773	5845.853

in model (3), or combined revenue dependence in model (4), none of the measures is significant, though the signs have reversed from in FE estimation.

Among other controls in FD, the impact of earthquake frequency on district economic performance is similar to that found in FE in all models, though it is now defined as a cumulative total of each district's earthquakes over the 10 year period (2006-2015). Interestingly, the coefficient on baseline GRDP per capita is significantly negative in all four models at the 1 per cent level, suggesting that there has been convergence of incomes between poorer and richer districts during the decentralisation period. Among other control variables, the sign of the urban dummy variable is positive but not significant in any specification.

Figure 3. Mining Dependence vs. Real GRDP per capita (averaged over time)



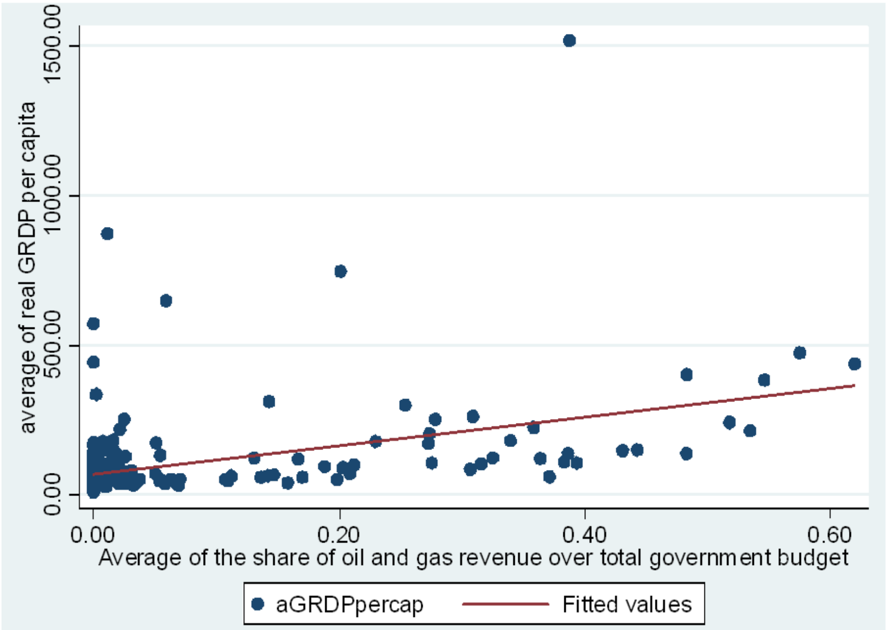
There is marginal evidence that districts located in Java have grown more rapidly than other districts, though significant only at the 10% level in model (1).

To summarize, with first difference models where potential endogeneity of resource dependence is not yet addressed, we again find evidence that dependence of output on mining resources is positively associated with real GRDP, and no clear evidence that government revenue dependence affects real GRDP.

We finally move to what we believe are our most credible specifications, FD with instrumental variables. Models $(1'), (2'), (3')$ and $(4')$ of Table 6 provide results using the continous form of our abundance type instruments (along with change in output instruments), while the same columns in Table 7 provides results with binary type abundance instruments. Recall that the continous abundance instruments are defined as the total number of major and minor petroleum (oil and natural gas) fields in the 1970's, and the share of coal deposit areas to total district areas in the 1980's.

We start with whether the continuous instruments satisfy relevance and overidentification tests. The instruments are strong, with Kleibergen Paap Wald F statistic rangings from 14.8 in model (4'), to 27.7 in model (2'). These values exceed Stock and Yogo critical values at the 10% maximal IV size (the critical value is 19.93), with the exception of

Figure 4. Oil + Gas Revenue Dependence vs. Real GRDP per capita (averaged over time)



model (4′), where it only exceeds the 15% maximal size. Regarding overidentification, the Hansen J statistic fails to reject the null hypothesis of exogenous instruments in all models (1′) to (4′), though with a p value of only 0.1486 in model (4′) of 0.1486. Thus our instruments appear valid for Table 6.

We next test whether our (change in) resource dependence measures, the ΔNR_i for each model, are exogenous. In the share of GRDP model (1′), the p value from a Hausman-type endogeneity test cannot reject exogeneity (p value 0.2481), whereas in all share of revenue models (2′), (3′), and (4′) exogeneity can be clearly or marginally rejected, with p values of 0.015, 0.018, and .108, respectively. For Table 6 we therefore take models (1), (2′), (3′) to be the most credible, with ambiguous evidence between (4) and (4′).

Just as in the FD case without instruments, we find no evidence that non-renewable resource dependence creates an adverse effect on growth. Instead, we now find evidence of a positive effect on growth of local government dependence on oil and gas (model (2′)) and of dependence of revenue on mining overall for model (4′) if instruments are used. As before however, we find no signifcant effect on growth of coal revenue dependence in model (3′), though with a negative sign. More specifically, an increase of a standard deviation in the change in oil and gas revenue dependence increases long run real income per capita by

Table 5 Panel Fixed Effect Model of the Effect of Resource Dependence on real GRDP per capita

Dependent Variable: GRDP per capita (in logs)

VARIABLES	(1) FE1	(2) FE2	(3) FE3	(4) FE4
Mining Dependence	0.406***			
	(0.113)			
Oil&Gas Revenue		0.167		
		(0.170)		
Coal revenue			-0.421*	
			(0.241)	
Mining Revenue				0.0353
				(0.132)
Earthquake	-0.0159*	-0.0164*	-0.0167*	-0.0168*
	(0.00834)	(0.00873)	(0.00876)	(0.00876)
Labour force	0.105	0.117	0.104	0.117
	(0.0784)	(0.0776)	(0.0784)	(0.0771)
Household elect.	-0.0728	-0.00834	-0.00453	-0.00701
	(0.0888)	(0.0921)	(0.0929)	(0.0922)
Constant	3.891***	3.867***	3.879***	3.869***
	(0.0752)	(0.0763)	(0.0761)	(0.0764)
Year Effect	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes
Observations	4,290	4,290	4,290	4,290
R-squared	0.492	0.478	0.479	0.478
Number of DISTRICT1	390	390	390	390

Notes:

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

(0.091*1.765 = 0.1606) 16.1 per cent. If instruments are used, a standard deviation increase in overall mining revenue dependence increases income by (0.084*1.164=0.0982) 9.8 per cent. These findings do not support a resource curse, but are consistent with past desriptive claims about the beneficial effects of past oil booms in Indonesia (see Gylfason, 2001; Rosser, 2007; Sovacool, 2010).

The effects of other control variables are generally similar to the FD model without instruments. For example, the cumulative number of earthquakes over 10 years negatively affects per capita income growth at district level in Indonesia in all four models of resource dependence. Initial GRDP per capita again has a strong negative association with district income per capita, indicating convergence as before.

Table 6 First difference model of effect of resource dependence on GRDP per capita (continous abundance levels plus change in production IV's)

Dependent Variable: ΔGRDP per capita (in logs)

	(1)	(1′)	(2)	(2′)	(3)	(3′)	(4)	(4′)
VARIABLES	**OLS**	**IV-GMM**	**OLS**	**IV-GMM**	**OLS**	**IV-GMM**	**OLS**	**IV-GMM**
ΔMining Dependence	0.738***	1.356***						
	(0.190)	(0.444)						
ΔOilgas Revenue			-0.160	1.765**				
			(0.473)	(0.810)				
ΔCoal Revenue					0.469	-0.696		
					(0.522)	(0.645)		
ΔMining Revenue							-0.0757	1.164**
							(0.389)	(0.581)
Earthquake	-0.0325**	-0.0306*	-0.0336***	-0.0347***	-0.0319***	-0.0373***	-0.0341***	-0.0264**
	(0.0133)	(0.0181)	(0.0118)	(0.0131)	(0.0118)	(0.0122)	(0.0122)	(0.0111)
ΔLabour force partic.rate	0.0369	0.0589	0.0254	0.0513	0.0730	-0.0445	0.0195	0.215
	(0.186)	(0.189)	(0.192)	(0.234)	(0.189)	(0.201)	(0.206)	(0.179)
Ln GRDP per capita, 2005	-0.113***	-0.111***	-0.148***	-0.0350	-0.150***	-0.119***	-0.141***	-0.0973**
	(0.0318)	(0.0355)	(0.0366)	(0.0663)	(0.0342)	(0.0386)	(0.0294)	(0.0394)
Population, 2005 (in logs)	0.00758	0.0234	0.000282	0.0212	0.00390	-0.00568	0.000152	0.0315
	(0.0233)	(0.0203)	(0.0258)	(0.0263)	(0.0255)	(0.0254)	(0.0265)	(0.0212)
DURBAN	0.0455	0.0751*	0.0402	0.0119	0.0473	0.0181	0.0364	0.0479
	(0.0421)	(0.0415)	(0.0420)	(0.0585)	(0.0447)	(0.0474)	(0.0438)	(0.0447)
DJAVA	0.0845*	0.114*	0.0380	-0.0477	0.0364	0.0291	0.0340	-0.0222
	(0.0483)	(0.0598)	(0.0467)	(0.0496)	(0.0437)	(0.0433)	(0.0451)	(0.0419)
Constant	0.730**	0.487*	0.983***	0.351	0.938***	0.973***	0.961***	0.397
	(0.290)	(0.282)	(0.357)	(0.323)	(0.328)	(0.320)	(0.350)	(0.256)
Cragg-Donald Wald F stat		8.900		29.017		111.683		27.509
Kleibergen-Paap Wald F		16.834		27.754		25.347		14.807
Hansen J statistic, P-value		0.2228		0.3552		0.6354		0.1486
Endogeneity test, P value		0.2481		0.0149		0.0178		0.1081
Observations	390	390	390	390	390	390	390	390
R-squared	0.158	0.103	0.075	-0.107	0.077	0.065	0.074	-0.001

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

As a robustness check, we try a similar exercise to Table 6 with binary definitions of historical abundance in Table 7. As previously described, districts are classified as oil and gas abundant if they contained at least one major field, and coal abundant if coal deposit agreements take up 20% of its land area or more. Kleibergen F statistics still indicate instrument strength for all revenue dependence models (2′), (3′) and (4′), with F values between 13.896 and 30.976, respectively. Instruments are weaker, however, for GRDP share in model (1′) with an F value of 7.76. More happily, overidentification test p values are clearly above rejection thresholds in all models. Thus the binary abundance instruments combined (combined with physical production change instruments) are valid, albeit with some weakness in model (1′). Exogeneity tests for resource dependence again indicate as before that it cannot be rejected for model (1) and can be rejected for (2′), and can now more clearly be rejected in (4′), but now not rejected for model (3). We therefore treat (1), (2′), (3) and (4′) as our most credible specifations.

Moving to findings, we find that resource dependence is significantly positively associated with GRDP in three of four models – mining's share of GRDP, oil and gas revenue dependence, and overall mining revenue dependence. The coefficient on coal revenue dependence in (3) is positive also, but not significant. To illustrate, in model (2′), a one standard deviation increase in the change in oil and gas revenue dependence is associated with an increase in per capita GRDP of about (0.091*1.359 = 0.124) 12.4 per cent. Thus, with binary abundance instruments, we find our strongest evidence of a resource blessing, with mining's share of GRDP or oil and gas or overall mining's share of local government revenue positively associated with per capita real income, and thus with growth.

5 Discussion and Conclusion

Overall, we have almost no evidence of a resource curse within Indonesia. Rather, with estimation methods that control for unobserved heterogeneity between districts that could affect their growth in GRDP, and valid instruments for potentially endogenous measures of resource dependence, we find strong evidence of a classical resource blessing. When resource dependence is measured as the share mining (oil, gas and coal) holds in a district's gross regional domestic product, MINDEP, we find this is significantly positively associated with GRDP in fixed effects estimation, and first difference estimation, with or without

Table 7 First difference model of effect of resource dependence on GRDP per capita (binary abundance levels plus change in production IV’s)

Dependent Variable: ΔGRDP per capita in logs

	(1)	**(1′)**	**(2)**	**(2′)**	**(3)**	**(3′)**	**(4)**	**(4′)**
VARIABLES	**OLS**	**IV-GMM**	**OLS**	**IV-GMM**	**OLS**	**IV-GMM**	**OLS**	**IV-GMM**
ΔMining Dependence	0.738***	1.143**						
	(0.190)	(0.579)						
ΔOilgas Revenue			-0.160	1.359*				
			(0.473)	(0.710)				
ΔCoal Revenue					0.469	-0.456		
					(0.522)	(0.708)		
ΔMining Revenue							-0.0757	1.059*
							(0.389)	(0.637)
Earthquake	-0.0325**	-0.0310*	-0.0336***	-0.0341***	-0.0319***	-0.0352***	-0.0341***	-0.0273**
	(0.0133)	(0.0181)	(0.0118)	(0.0124)	(0.0118)	(0.0121)	(0.0122)	(0.0113)
ΔLabour force partic.rate	0.0369	0.135	0.0254	0.0677	0.0730	-0.00293	0.0195	0.237
	(0.186)	(0.186)	(0.192)	(0.218)	(0.189)	(0.202)	(0.206)	(0.173)
Ln GRDP per capita, 2005	-0.113***	-0.108***	-0.148***	-0.0559	-0.150***	-0.128***	-0.141***	-0.0872**
	(0.0318)	(0.0351)	(0.0366)	(0.0563)	(0.0342)	(0.0384)	(0.0294)	(0.0391)
Population, 2005 (in logs)	0.00758	0.0286	0.000282	0.0200	0.00390	0.000595	0.000152	0.0308
	(0.0233)	(0.0199)	(0.0258)	(0.0247)	(0.0255)	(0.0256)	(0.0265)	(0.0209)
DURBAN	0.0455	0.0687	0.0402	0.0186	0.0473	0.0299	0.0364	0.0392
	(0.0421)	(0.0421)	(0.0420)	(0.0526)	(0.0447)	(0.0470)	(0.0438)	(0.0436)
DJAVA	0.0845*	0.0933	0.0380	-0.0322	0.0364	0.0253	0.0340	-0.0186
	(0.0483)	(0.0658)	(0.0467)	(0.0472)	(0.0437)	(0.0434)	(0.0451)	(0.0430)
Constant	0.730**	0.415	0.983***	0.430	0.938***	0.919***	0.961***	0.368
	(0.290)	(0.281)	(0.357)	(0.293)	(0.328)	(0.322)	(0.350)	(0.257)
Cragg-Donald Wald F stat		8.108		41.389		115.597		31.065
Kleibergen-Paap Wald F		7.759		30.976		27.580		13.896
Hansen J statistic, P-value		0.2691		0.4555		0.6313		0.4702
Endogeneity test, P value		0.6970		0.0180		0.1674		0.0630
Observations	390	390	390	390	390	390	390	390
R-squared	0.158	0.136	0.075	-0.036	0.077	0.072	0.074	0.012

Note: Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

instruments. In our most credible specification (first difference without instruments), a standard deviation increase in the change is MINDEP increases real GRDP per capital between 2006 and 2015 by 7.27%. Evidence is less robust for resource dependence is measured as the share resource tax revenues play in district government budgets. But even here, where endogeneity is addressed using valid instruments, we find that dependence on oil and gas revenues, or from overall mining revenues, is also positively associated with growth. In our most credible specification (first difference with continous instruments), a standard deviation increase in the change in OILGASREV increases income between 2006 and 2015 by 16.1%. The only resource dependence measure for which we find no pro-growth effects is coal revenue dependence. Table 8 provides a qualitative summary of our findings.

In the context of the resource curse literature, our results are in contrast with findings from some prominent between-country studies (from Sachs and Warner (1995), (1999)) or Collier and Goderis 2009), but consistent with findings from most within-country studies (e.g. Caselli and Michaels (2013) for Brazil, Fan, Fang, & Park (2012) for China, Aragón and Rud (2013) for Northern Peru, and Libman (2013) for Russia). For Indonesia in particular, where little work has been done, our findings contrast with those of Komarulzaman and Alisjahbana (2006) who found mining rents were negatively associated with growth. However, this latter study was among the first regression based papers addressing the resource curse in Indonesia, and was based on cross section data for a single year, without control for the endogeneity of its rents measure. Our results are consistent with those of Cust and Rusli (2016), who when following districts over time and using instruments, find oil and gas revenue dependence to be positively associated with growth in district GRDP. We confirm this result, but using more recent and reliable data (post decentralisation), additional instruments, and the alternative resource dependence measure of mining's share of GRDP.

To the extent that even some within country studies do find evidence of a resource curse (e.g. Papyrakis and Gerlagh (2007), James and Aadland (2011) and Douglas and Walker (2016) in the United States, or Guo, Zheng, and Song (2016) in China), we might ask why such a curse is absent in Indonesia. For as a resource rich developing country with recent experience of authoritarian governance and corruption, Indonesia might have seemed a prime candidate for a resource curse.

First, the oil boom during the 1970's and 1980's, and the coal boom during the 2000's, have tremendously contributed to Indonesia's non-tax revenues. Even before decentralisation

Table 8 Summary of Results

	Share of GRDP (1)	**Rev Dependence Oil & Gas (2)**	**Rev Dependence Coal (3)**	**Rev Dependence all Mining (4)**
FE	+	0	–	0
FD	+	0	0	0
FD with instrument 1	+	+	0	+
FD with instrument 2	+	+	0	+

Notes: FE = Fixed Effect; FD = First Difference; Instrument 1 is continous abundance level instruments plus changes of physical production; Instrument 2 is binary abundance level instruments plus changes of physical production;

revenue sharing formulas, these booms accelerated growth in outlying regions such as Eastern and Southern Kalimantan and Sumatra. Regional studies of Indonesia have consistently identified these regions as being the most prosperous by GRDP per capita between 1999 and 2011 (Hill, Resosudarmo, Vidyattama, 2008; Hill and Vidyattama, 2016). Other, sometimes descriptive studies have also noted that Indonesia has avoided a resource curse (Usui (1997), Rosser (2007), di John (2011) and Chandra (2012). These studies argue that Indonesia successfully escaped a Dutch disease during earlier oil price booms in 1973-1985 as a result of using its oil windfalls to strengthen both its agricultural and manufacturing sectors. Although such “activist” industrial policy interventions have not persisted, they may have benefited resource intensive regions in the years prior to decentralisation.

Second, along with the implementation of decentralisation of public good provision and funding, the central government of Indonesia has encouraged the accountability of district governments to improve their performance through incentive systems of rewards and punishments.[17] Financial audit investigations, for example, have been conducted annually by the Indonesia Audit Board (BPK) since 2005. The BPK investigates the performance of the central government, including State Owned Enterprises (BUMN), but it also investigates

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[17] See Davoodi and Zou (1998) for a detailed discussion of how fiscal decentralisation may raise economic efficiency if district governments are better placed to provide local public services, and if competition between district governments and rapid mobility of citizens results in better matching of preferences between governments and local people.

local district local governments regarding the quality of their financial reporting. The BPK announces their findings every six months. Even more ambitiously, since 2010, the Indonesian Ministry of Home Affairs has annually evaluated district governments and ranked them based upon their performance across several critera.[18] This too is publicly circulated.

Thus, to the extent improved governance can forestall a resource curse, Indonesia's specific implementation of decentralisation may have contributed. The resource revenue redistribution formula put in place in 2004 may have contributed to expanding the ability of local districts to fund their broadened activities, and the incentives also put in place may have ensured these activities have contributed to economic growth.

Our study cannot pinpoint the mechanisms through which resource dependence aids per capita income within Indonesia, and nor can we be sure that rising per capita income translates to broader development objectives in health, education, or poverty reduction. Nonetheless, when holding constant the institutional features common throughout Indonesia, we find evidence that on average, dependence of GRDP or government revenues on mining has been a blessing, rather than curse, to real per capita income.

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[18] Specifically, the Ministry of Home Affairs investigates and ranks districts according to their compliance with national rules and procedures, effectiveness of public consultation, transparency in budget planning and reporting, and innovation to improve the local region.

6 References

Aden, Jean. 2001. "Decentralisation of Natural Resource Sectors in Indonesia: Opportunities and Risks." 23148. EASES Discussion Paper Series.

Alexeev, Michael, and Robert Conrad. 2011. "The Natural Resource Curse and Economic Transition." *Economic Systems* 35 (4). Elsevier B.V.: 445–61. doi:10.1016/j.ecosys.2010.10.003.

———. 2016. "The Elusive Curse of Oil." *The Review of Economics and Statistics* 91 (3): 586–98.

Aragón, By Fernando M, and Juan Pablo Rud. 2013. "Natural Resources and Local Communities : Evidence from a Peruvian Gold Mine." *American Economic Journal: Economic Policy* 5 (2): 1–25.

Aragona, Fernando M., Punam Chuhan-Pole, and Bryan Christopher Land. 2015. "The Local Economic Impacts of Resource Abundance: What Have We Learned?" 7263. Policy Research Working Paper. http://econ.worldbank.org.

Arezki, Rabah, and Frederick van der Ploeg. 2011. "Do Natural Resources Depress Income per Capita?" *Review of Development Economics* 15 (3): 504–21. doi:10.1111/j.1467-9361.2011.00623.x.

Auty, Richard M. 1994. "Industrial Policy Reform in Six Large Newly Industrializing Countries: The Resource Curse Thesis." *World Development* 22 (1): 11–26. doi:10.1016/0305-750X(94)90165-1.

Badeeb, Ramez Abubakr, Hooi Hooi Lean, and Jeremy Clark. 2017. "The Evolution of the Natural Resource Curse Thesis: A Critical Literature Survey." *Resources Policy* 51 (December 2016). Elsevier: 123–34. doi:10.1016/j.resourpol.2016.10.015.

Barro, Robert J. 1991. "Economic Growth in a Cross Section of Countries." *Quarterly Journal of Economics* 106 (2): 407–37.

Bee, Ooi Jin. 1982. *The Petroleum Resources of Indonesia*. First Edit. Kuala Lumpur: Oxford University Press.

Bjorvatn, Kjetil, Mohammad Reza Farzanegan, and Friedrich Schneider. 2012. "Resource Curse and Power Balance: Evidence from Oil-Rich Countries." *World Development* 40 (7). Elsevier Ltd: 1308–16. doi:10.1016/j.worlddev.2012.03.003.

Brown, T J., N E. Idoine, E R. Raycraft, R A. Shaw, E A. Deady, S F. Hobbs, and T. Bide. 2017. *World Mineral Production 2011-2015*. British Geological Survey publishers.

Brunnschweiler, Christa N., and Erwin H. Bulte. 2008. "The Resource Curse Revisited and Revised: A Tale of Paradoxes and Red Herrings." *Journal of Environmental Economics and Management* 55 (3): 248–64. doi:10.1016/j.jeem.2007.08.004.

Bulte, Erwin H., Richard Damania, and Robert T. Deacon. 2005. "Resource Intensity, Institutions, and Development." *World Development* 33 (7): 1029–44. doi:10.1016/j.worlddev.2005.04.004.

Caselli, Francesco, and Guy Michaels. 2013. “Do Oil Windfalls Improve Living Standards? Evidence from Brazil.” *American Economic Journal: Applied Economics* 5 (1): 208–38. doi:10.1257/app.5.1.208.

Chandra, Wendy. 2012. “The Impact of Dependency on Primary Commodity on Indonesia Economic Growth.”

Collier, Paul, and Benedikt Goderis. 2009. “Commodity Prices, Growth, and the Natural Resource Curse: Reconciling a Conundrum.” 17315. *MPRA Paper No. 17315*. MPRA. http://users.ox.ac.uk/~econpco/research/pdfs/CommodityPricesGrowthV1-1.pdf.

Cust, James, and Steven Poelhekke. 2015a. “The Local Economic Impacts of Natural Resource Extraction.” *Annual Review of Resource Economics* 7 (1): 251–68. doi:10.1146/annurev-resource-100814-125106.

———. 2015b. “The Local Economic Impacts of Natural Resource Extraction Extraction.” *Annual Review of Resource Economics* 7 (0).

Cust, James, and Ridwan D Rusli. 2016. “Disentangling the Effects of Resource Extraction : Quantifying Local Government and Project Multipliers.”

Davoodi, Hamid, and Heng-fu Zou. 1998. “Fiscal Decentralisation and Economic Growth : A Cross-Country Study.” *Journal of Urban Economics* 43: 244–57.

Douglas, Stratford, and Anne Walker. 2016. “Coal Mining and the Resource Curse in the Eastern United States.” *Journal of Regional Science* 0 (0): 1–23. doi:10.1111/jors.12310.

Edwards, Ryan B. 2016a. “Mining Away the Preston Curve.” *World Development* 78. Elsevier Ltd: 22–36. doi:10.1016/j.worlddev.2015.10.013.

Edwards, Ryan Barclay. 2016b. “Natural Resource Sectors and Human Development: International and Indonesian Evidence.” Australian National University. https://openresearch-repository.anu.edu.au/handle/1885/101148.

Fan, Rui, Ying Fang, and Sung Y. Park. 2012. “Resource Abundance and Economic Growth in China.” *China Economic Review* 23 (3). Elsevier Inc.: 704–19. doi:10.1016/j.chieco.2012.04.007.

Frankel, Jeffrey A. 2010. “The Natural Resource Curse: A Survey.” 15836. *NBER Working Paper Series*. doi:10.2139/ssrn.1565588.

Friederich, Mike C., and Theo van Leeuwen. 2017. “A Review of the History of Coal Exploration, Discovery and Production in Indonesia: The Interplay of Legal Framework, Coal Geology and Exploration Strategy.” *International Journal of Coal Geology*. Elsevier B.V. doi:10.1016/j.coal.2017.04.007.

Gylfason, Thorvaldur. 2001. “Natural Resources, Education, and Economic Development.” *European Economic Review* 45 (4–6): 847–59. doi:10.1016/S0014-2921(01)00127-1.

Gylfason, Thorvaldur. 2009. “Development and Growth in Mineral-Rich Countries.” *Sustainable Growth and Resource Productivity: Economic and Global Policy Issues*, no. April: 42–84. doi:10.9774/GLEAF.978-1-907643-06-4_5.

Gylfason, Thorvaldur, and Gylfi Zoega. 2006. “Natural Resources and Economic Growth: The Role of Investment.” *World Economy* 29 (8): 1091–1115. doi:10.1111/j.1467-9701.2006.00807.x.

Hajkowicz, Stefan A., Sonja Heyenga, and Kieren Moffat. 2011. “The Relationship between Mining and Socio-Economic Well Being in Australia’s Regions.” *Resources Policy* 36 (1). Elsevier: 30–38. doi:10.1016/j.resourpol.2010.08.007.

Hill, Hal, Budy P. Resosudarmo, and Yogi Vidyattama*. 2008. “Indonesia’s Changing Economic Geography.” *Bulletin of Indonesian Economic Studies* 44 (3): 407–35. doi:10.1080/00074910802395344.

Hill, Hal, and Vidyattama, Yogi. 2016. “Regional Development Dynamics in Indonesia Before and After the ‘Big Bang’ Decentralization.” *The Singapore Economic Review* 61 (2): 1640027. doi:10.1142/S0217590816400270.

Humphreys, Macartan, Jeffrey D. Sachs, and Joseph E. Stiglitz. 2007. *Escaping the Resource Curse*. New York: Columbia University Press.

ICC. 2013. “Coal Mining Is Private Participation the Answer?, Indian Chamber of Commerce.” https://www.pwc.in/assets/pdfs/industries/power-mining/coal-mining-icc-report-v2-300613.pdf.

Indonesia, PwC. 2018. “Oil and Gas in Indonesia, Investment and Taxation Guide.” PT PricewaterhouseCoopers Indonesia. *www.pwc.com/id*

Isham, Jonathan, Michael Woolcock, Lant Pritchett, and Gwen Busby. 2005. “The Varieties of Resource Experience : Natural Resource Export Structures and the Political Economy of Economic Growth.” *The World Bank Economic Review* 19 (2): 141–74. doi:10.1093/wber/lhi010.

James, Alex, and David Aadland. 2011. “The Curse of Natural Resources: An Empirical Investigation of U.S. Counties.” *Resource and Energy Economics* 33 (2). Elsevier B.V.: 440–53. doi:10.1016/j.reseneeco.2010.05.006.

James, Alexander. 2015. “The Resource Curse: A Statistical Mirage?” *Journal of Development Economics* 114. Elsevier B.V.: 55–63. doi:10.1016/j.jdeveco.2014.10.006.

John, Jonathan di. 2011. “Is There Really a Resource Curse? A Critical Survey of Theory and Evidence.” *Global Governance* 17 (2): 167–84.

Komarulzaman, Ahmad, and Armida S Alisjahbana. 2006. “Testing the Natural Resource Curse Hypothesis in Indonesia : Evidence at the Regional Level.” *Working Paper in Economics and Development Studies*, no. 200602.

Lederman, Daniel, and William F Maloney. 2003. “Trade Structure and Growth.” 3025.

Leeuwen, Theo M Van. 1994. “25 Years of Mineral Exploration and Discovery in Indonesia.” *Journal of Geochemical Exploration* 50: 13–90.

Lei, Yalin, Na Cui, and Dongyang Pan. 2013. “Economic and Social Effects Analysis of Mineral Development in China and Policy Implications.” *Resources Policy* 38 (4). Elsevier: 448–57. doi:10.1016/j.resourpol.2013.06.005.

Libman, Alexander. 2013. “Natural Resources and Sub-National Economic Performance: Does Sub-National Democracy Matter?” *Energy Economics* 37. Elsevier B.V.: 82–99. doi:10.1016/j.eneco.2013.02.003.

Loayza, Norman, and Jamele Rigolini. 2016. “The Local Impact of Mining on Poverty and Inequality: Evidence from the Commodity Boom in Peru.” *World Development* 84. Elsevier Ltd: 219–34. doi:10.1016/j.worlddev.2016.03.005.

Mcmahon, Gary, and Susana Moreira. 2014. “The Contribution of the Mining Sector to Socioeconomic and Human Development.” 87298. Extractive Industries for Development Series.

Mehlum, Halvor, Karl Moene, and Ragnar Torvik. 2006. “Institutions and the Resource Curse.” *Economic Journal* 116 (508): 1–20. doi:10.1111/j.1468-0297.2006.01045.x.

North, D. C. 1982. *Economics in the Long View: Essays in Honour of W.W. Rostow*. Edited by Charles P. Kindleberger and Guido di Tella. *The Theoritical Tools of the Economic Historian*. Volume I. The MacMillan Press LTD. doi:10.1017/CBO9781107415324.004.

Ouoba, Youmanli. 2016. “Natural Resources: Funds and Economic Performance of Resource-Rich Countries.” *Resources Policy* 50. Elsevier: 108–16. doi:10.1016/j.resourpol.2016.09.003.

Papyrakis, Elissaios. 2016. “The Resource Curse - What Have We Learned from Two Decades of Intensive Research: Introduction to the Special Issue.” *Journal of Development Studies* 53 (April). Routledge: 1–11. doi:10.1080/00220388.2016.1160070.

Papyrakis, Elissaios, and Reyer Gerlagh. 2004. “The Resource Curse Hypothesis and Its Transmission Channels.” *Journal of Comparative Economics* 32 (1): 181–93. doi:10.1016/j.jce.2003.11.002.

———. 2007. “Resource Abundance and Economic Growth in the United States.” *European Economic Review* 51 (4): 1011–39. doi:10.1016/j.euroecorev.2006.04.001.

Ploeg, Frederick Van Der. 2011. “Natural Resources: Curse or Blessing?” *Journal of Economic Literature* 49 (2): 366–420. doi:10.1257/jel.49.2.366.

Ploeg, Frederick van der, and Steven Poelhekke. 2016. “The Impact of Natural Resources: Survey of Recent Quantitative Evidence.” *Journal of Development Studies* 53 (April). Routledge: 1–12. doi:10.1080/00220388.2016.1160069.

Ross, Michael L. 2001. “Does Oil Hinder Democracy?” *World Politics* 53 (3): 325–61. doi:10.1353/wp.2001.0011.

Rosser, Andrew. 2007. “Escaping the Resource Curse: The Case of Indonesia.” *Journal of Contemporary Asia* 37 (773564139): 38–58. doi:10.1080/00472330601104557.

Rostow, W. W. 1959. “The Stages of Economic Growth.” *The Economic History Review* 12 (1): 1–16.

Sachs, Jeffrey D., and Andrew M. Warner. 1995. “Natural Resource Abundance and Economic Growth.” 5398. *NBER Working Paper Series*. Vol. 3. doi:10.3386/w5398.

Sachs, Jeffrey D., and Andrew M. Warner. 1999. “The Big Push, Natural Resources Boom and Growth.” *Journal of Development Economics* 59 (59): 43–76. doi:10.1016/S0304-3878(99)00005-X

Sovacool, Benjamin K. 2010. “The Political Economy of Oil and Gas in Southeast Asia: Heading towards the Natural Resource Curse?” *The Pacific Review* 23 (2): 225–59. doi:10.1080/09512741003624484.

Stijns, Jean-Philippe C. 2000. “Natural Resource Abundance and Economic Growth Revisited.” *Resources Policy* 30 (2): 1–40. doi:10.1016/j.resourpol.2005.05.001.

Temple, Jonathan. 1999. “The New Growth Evidence.pdf.” *Journal of Economic Literature* 37 (1): 112–56.

Torvik, Ragnar. 2009. “Why Do Some Resource-Abundant Countries Succeed While Others Do Not?” *Oxford Review of Economic Policy* 25 (2): 241–56. doi:10.1093/oxrep/grp015.

Usui, Norio. 1997. “Dutch Disease and Policy Adjustments to the Oil Boom: A Comparative Study of Indonesia and Mexico.” *Resources Policy* 23 (4): 151–62. doi:10.1016/S0301-4207(97)00023-8.

Weber, Jeremy G. 2012. “The Effects of a Natural Gas Boom on Employment and Income in Colorado, Texas, and Wyoming.” *Energy Economics* 34 (5). Elsevier B.V.: 1580–88. doi:10.1016/j.eneco.2011.11.013.

———. 2014. “A Decade of Natural Gas Development: The Makings of a Resource Curse?” *Resource and Energy Economics* 37. Elsevier B.V.: 168–83. doi:10.1016/j.reseneeco.2013.11.013.

Wooldridge, Jeffrey M. 2016. *Introductory Econometrics, 6e*. Cengage Learning.

World Mining Data 2018. Federal Ministry of Sustainability and Tourism (BMNT). http://www.world-mining-data.info/wmd/downloads/PDF/WMD2018.pdf

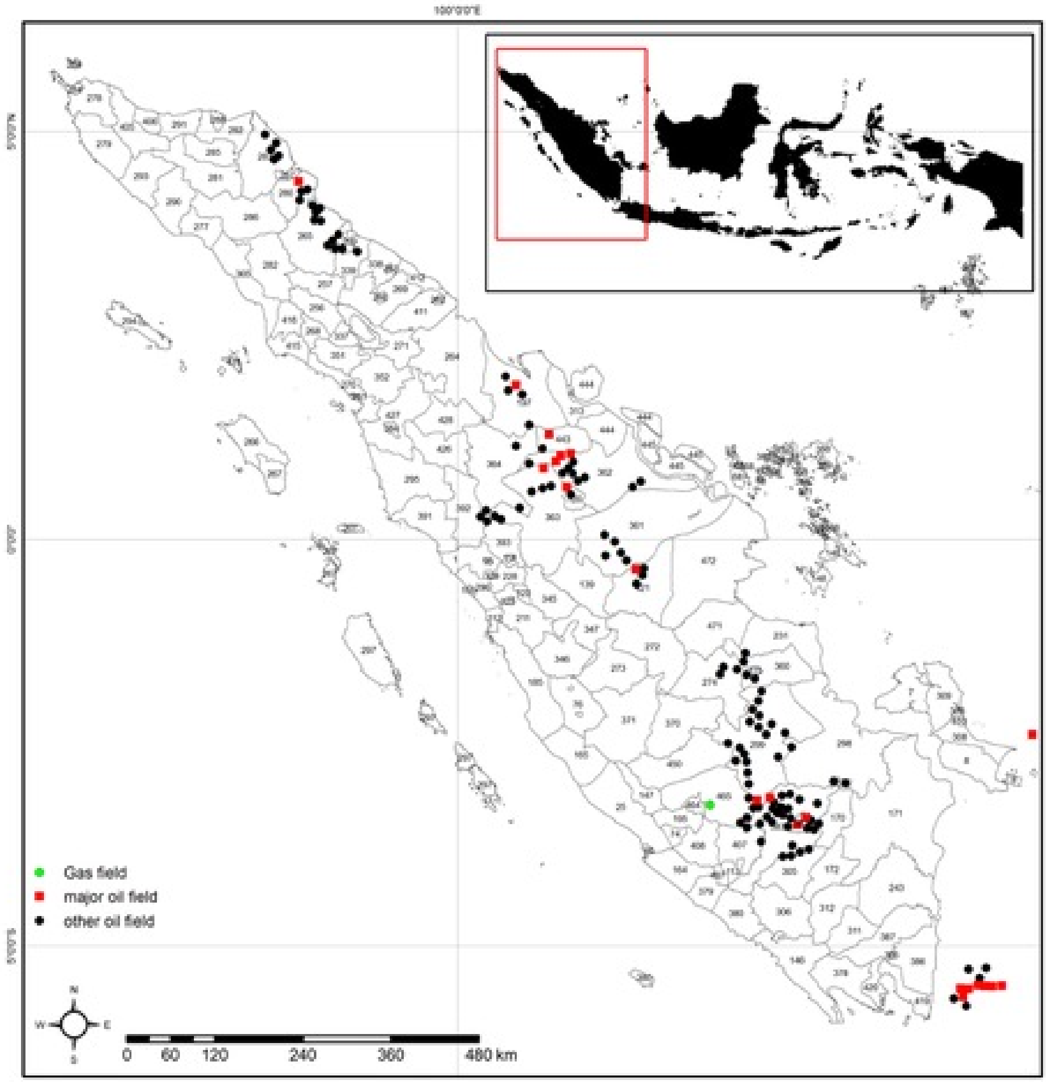
Appendix 1: Definition of Variables and Data Sources

Variable	Definition	Source
Real GRDP per capita	Natural logarithm of the GRDP (Real Gross Regional Domestic Product) divided by total population at district level	INDO DAPOER World Bank, The Indonesian National Statistical Agency (BPS)
Earthquake	The number of earthquake events at the district level	Indonesian National Board for Disaster Management (BNPB). Can be accessed online here: http://bnpb.cloud/bnpb/tabel1
Labour force participation rate	Natural logarithm of the participation of labour force in the number of people at working age (15-65)	INDO DAPOER World Bank, BPS
LGRDP per capita '05	Natural logarithm of initial GRDP percapita in 2005	INDO DAPOER World Bank, BPS
LPOP_05	Natural logarithm of initial population in 2005	BPS
DURBAN	Dummy urban status (municipalities) = 1 if urban districts, = 0 if non-urban/rural district	Identity of urban district/municipality is taken from the Ministry of Home Affairs, the Republic of Indonesia
DJAVA	Dummy of Java Island = 1 if the districts are located on Java Island, = 0 otherwise	-
Household electricity	Per centage of households with an access to electricity.	INDO DAPOER World Bank
MINDEP	The ratio of mining GRDP to total GRDP (real)	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia
MINREV	The share of mining revenues, summing oil, natural gas, and coal revenues, in total government budget at district level	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia; BPS
OILGASREV	The share of oil and natural gas revenues in total government budget, at district level	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia; BPS

Variable	Definition	Source
COALREV	The share of coal and other minerals revenues in total government budget, at district level	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia; BPS
OILGAS BINARY	Dummy variable, = 1 if at least one major oil or gas field operated there during 1970's, = 0 otherwise.	Ooi Jin Bee (1982)
COAL BINARY	Dummy variable, =1 if at least 20% of district is covered by a "first generation" coal agreement contract during the 1970's, = 0 otherwise.	Leeuwen (1994,2017)
OILGAS CONTINOUS	The number of major and minor oil and gas fields in 1970's production period in all island in Indonesia. Major oil and natural gas fields is weigted by 1, and all minor fields are weighted by 0.25. So, if in district A has a 10 minor oil/gas fields location, therefore: $District_A = 10 \times 0.25 = 2.5$	Ooi Jin Bee (1982)
COAL CONTINOUS	The share of coal deposit areas (showed by first generation coal agreement contract introduced by Leeuwen (1994, 2017)) of total area of respective district.	Leeuwen (1994,2017)
ΔGRDP PER CAPITA	The natural logarithm of difference of real GRDP per capita, formulated as: $\Delta\text{GRDP per capita} = ln(\frac{GRDP_{percapita,2015}}{GRDP_{percapita,2006}})$	INDO DAPOER World Bank, BPS
ΔMINING DEPENDENCE	The difference of mining dependence between 2015 and 2006, formulated as: $(MINDEP_{2015}) - (MINDEP_{2006})$	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia
ΔMINING REVENUE	The difference in mining revenue shares, between 2015 and 2006	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia
ΔOILGAS REVENUE	The difference in oil and gas revenue shares, between 2015 and 2006	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia
ΔCOAL REVENUE	The difference in coal revenue shares, between 2015 and 2006	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia
ΔLABOUR FORCE PARTIC.RATE	The change in labour force participation rate between 2015 and 2006	INDO DAPOER World Bank, BPS

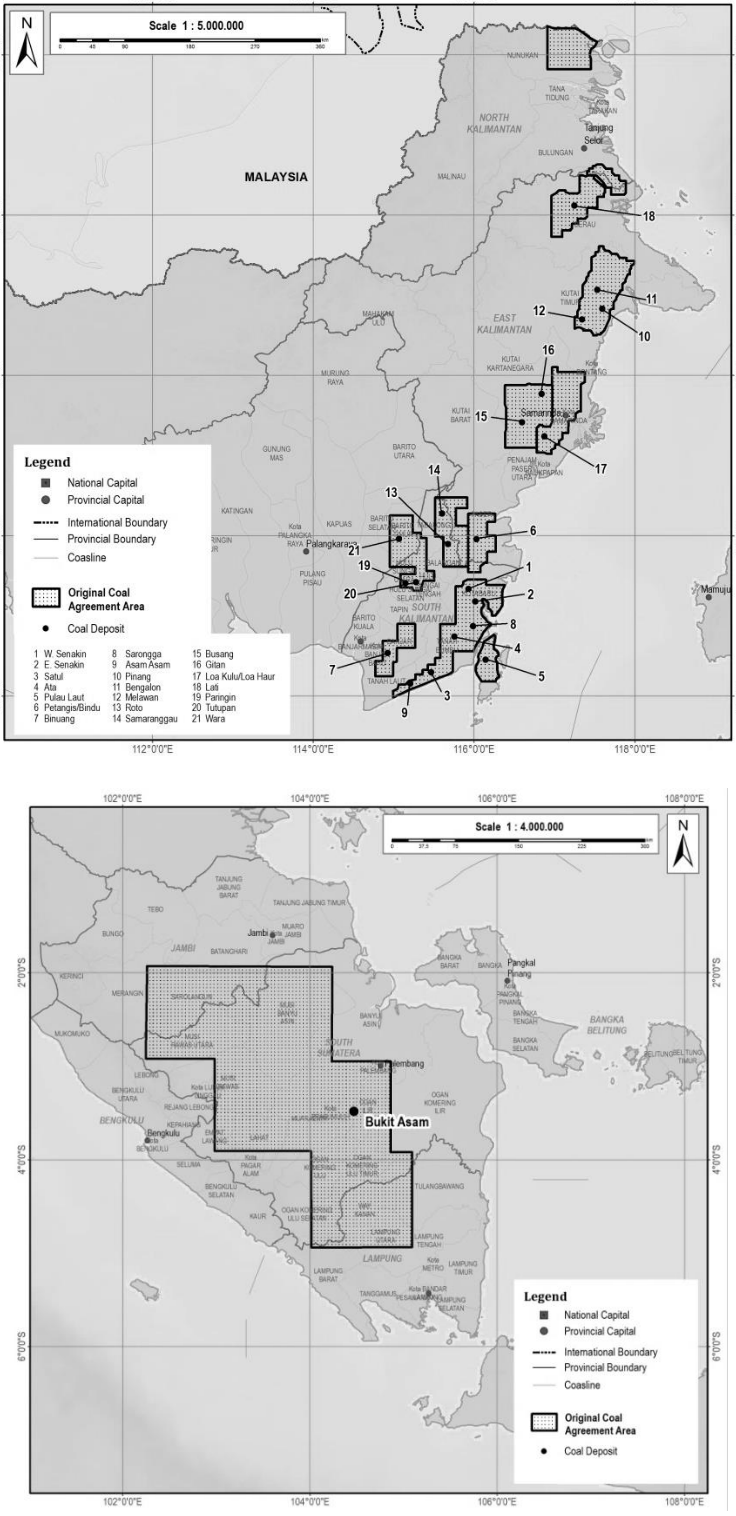
Variable	Definition	Source
ΔPOPULATION (LOGS)	The change in the population (in logs) between 2015 and 2006	INDO DAPOER World Bank, BPS
Δ COAL PRODUCTION	The change in coal land rents and royalties between 2015 and 2006	Ministry of Energy and Mineral Resources, Republic of Indonesia
ΔOIL PRODUCTION	The change in oil production (in barrels) between 2015 and 2006	Ministry of Energy and Mineral Resources, Republic of Indonesia
ΔGAS PRODUCTION	The change in natural gas production (in MMBTU) between 2015 and 2006	Ministry of Energy and Mineral Resources, Republic of Indonesia

Appendix 2: The Distribution of Major and Minor Oil and Gas Fields (Including Natural Gas) in Sumatra Island in the 1970's



Source: Ooi Jin Bee (1982), mapped to 2003 District Boundaries

Appendix 3: The Location of Coal Deposit Based on First Generation Contract Agreements, during the 1980's, Kalimantan and Sumatra Islands



Source: Friederich & van Leeuwen (2017); Leeuwen (1994), mapped to 2003 Boundaries