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Resource Dependence and the Causes of Local Economic Growth: An Empirical Investigation

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Abstract: Previous research has found that in Indonesia, a resource giant in South East Asia, resource dependence is positively associated with economic growth, contrary to a 'resource curse' hypothesis. We test four potential causal mechanisms for this positive effect: spill overs to manufacturing, higher education provision, improvements in institutional quality, and investment in public capital. We follow 390 districts within Indonesia from 2006 to 2015, using four alternative measures of resource dependence, and instrumenting for their potential endogeneity. We first confirm a positive overall effect of resource dependence on real per capita Gross Regional Domestic Product. We then test the extent to which resource dependence positively affects manufacturing, education, public investment, and district institutional quality. We finally test the extent to which these factors contribute to growth. We find that resource dependence aids growth in part by raising measures of district institutional quality. Resource dependence also raises net high school enrolment rates, though we do not find that this in turn raises growth. Conversely, while higher capital spending by districts raises growth, we find no evidence that this share is affected by resource dependence. In auxiliary analysis, we find little support for the hypothesis that resource dependence benefits growth more (or only) for districts that begin with higher institutional quality.

Keywords: Resource dependence, causal channels, economic growth, institutional quality

JEL Classifications: Q32, Q33, Q38, O13, O43, O47

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1 Introduction

There has been a continuing debate about whether resource endowments help or hinder economic growth. Traditionally, economic theory assumed that an abundance of natural resources would benefit a country's economy, either as a source to transform economic structures from traditional to industrial, or as a key input of a society's long-term output (Rostow 1959; North 1982). Yet after Sachs and Warners' (1995, 1999) investigations found an adverse correlation between resource dependence (each country's share of primary exports to total GNP) and average growth in GDP per capita, a growing stream of studies began to investigate a "resource curse", and the transmission channels through which it might operate.

Following numerous conflicting findings as to whether resource dependence reduces or raises growth, survey articles and individual studies have recommended that researchers pay closer attention to the endogeneity of resource use measures, and better address unobserved heterogeneity by using within-country studies along with cross-country ones (Brunschweiler and Bulte (2008), Cust and Poelhekke (2015), Aragon, Chuhan-Pole, and Land (2015), Papyrakis (2016), van der Ploeg and Poelhekke (2016) and Badeeb, Lean, and Clark (2017)). Many, though by no means all, within-country studies have found a positive effect of resource dependence on growth (see e.g. Caselli and Michaels (2013) for Brazil; Fan, Fang, & Park (2012) for China; and Aragón and Rud (2013) for Northern Peru, with contrary findings for the United States by Papyrakis and Gerlagh (2007) and Douglas and Walker (2016)).

Indonesia is a vast, populous developing country in Southeast Asia that is also a major producer and exporter of various non renewable resources.[1] The sheer size and variation in resource dependence across Indonesia, coupled with the improved availability of its district level data since its move to decentralisation between 1999 and 2004, make the country an excellent test case for the effects of resource dependence. Both Cust and Rusli (2016) and Hilmawan and Clark (2018), using panel regression and instruments, have found that district government revenues from oil and gas are positively associated with real per capita income. Hilmawan and Clark (2018) also find positive effects on growth of mining's share in district gross regional domestic product (GRDP).

Various causal mechanisms have been proposed through which non-renewable resource dependence may be harming (or advancing) economic growth. Testing these mechanisms for

[1] It is the world's 7th largest producer of mineral fuels, 6th largest coal producer and largest coal exporter, and 10th largest producer of natural gas (World Mining Data 2018; Indonesia, PwC, 2018; ICC, 2013; Brown, 2017). It is the 10th largest producer of natural gas.

explanatory power helps to support or falsify the overall 'resource curse', but also better predict when resource dependence will be a blessing or curse. This in turn can assist governments in resource abundant countries set resource policies that maximise their societies' gains from their resource endowments.

Channels proposed for the effect of resource dependence on a country's growth (historically developed for a resource curse) have included 1) crowding out of non-resource tradeable sectors that better aid growth in the long run, such as manufacturing (the "Dutch disease"), 2) depressing demand for education, 3) depressing institutional quality, and 4) providing perverse incentives regarding the quality of public spending (Bhattacharyya and Collier (2014); Collier and Goderis (2009); Karimu et al. (2017)).

Research has been far from conclusive about whether resource intensity works through these channels to negatively or positively affect growth. On the one hand, several empirical papers have indeed found a negative effect of resource dependence on school enrolment rates, or on public expenditures on education as a proxy for human capital investment (Gylfason 2001; Edwards, 2016). Resource dependence has also been found to delay manufacturing sector expansion ((Sachs and Warner (1995), Stijns, (2005)) and to worsen institutional quality by increasing incentives for rent-seeking behaviour, or unaccountable management of revenue windfalls (Ross, 2001; Isham, et al. (2005)).

Yet other researchers have found positive or no effects of resources on growth via these same channels. In the case of the Dutch disease, van der Ploeg (2011) has found it is less likely to happen in a country that initially has a relatively low share of manufacturing in GDP. Bulte, Damania, and Deacon (2005) have found cases where resource-rich countries experienced expansions in manufacturing during oil booms. Similarly, with respect to education, Stijns (2005); Alexeev and Conrad (2011) find higher resource intensity leads to higher education enrolment levels. With respect to institutional quality, Brunnschweiler (2008) and Brunnschweiler and Bulte (2009) find that resource intensity has no effect on measures of rule of law or government effectiveness.

These conflicting findings regarding causal mechanisms are perhaps not surprising since there is as yet no consensus regarding the overall association between resource intensity and economic growth. Some who try to synthesize the literature's conflicting findings argue that negative associations are more likely to occur in developing rather than developed countries (Arezki and van der Ploeg 2011; Frankel 2010). This brings us to an auxiliary hypothesis in this literature; a state's exogenous degree of institutional quality (e.g. corruption, accountability, rule of law) will determine whether resource dependence aids or hinders growth. In other words, resources may aid growth for countries who already possess strong institutions, but hinder it for those who do not (Arezki & van der Ploeg (2010), Papyrakis (2016), Mehlum, Moene, and Torvik (2006)).

In this paper, we seek to test the extent to which the four causal mechanisms above can explain the positive overall effect of resource dependence on per capita income found for Indonesia by Cust and Rusli (2016) and Hilmawan and Clark (2018). We continue this literature's recent practice of using panel methods, multiple resource dependence measures, and instruments for all resource dependence measures. We also test the synthesis "contingent curse" hypothesis that resource dependence is more likely to be a blessing for districts who have stronger initial capacity or quality of institutions, and a curse for those who do not.

The paper is structured as follows. In Section 2 we review the four potential transmission channels that we test between resource dependence and growth in income. Section 3 describes our data sources and empirical estimation strategy, while Section 4 provides our results. Section 5 provides a discussion of our findings and conclusions.

2 Literature Review

2.1 The manufacturing sector and the Dutch disease

An early explanation for negative effects of resource intensity on income was that a high dependency on natural resources delays or crowds out development of a country's manufacturing sector, whose expansion would otherwise generate greater growth over time. This phenomenon is called the "Dutch disease," named after the discovery of natural gas in the Dutch province of Groningen in the late 1950's (Frankel 2010). According to Davis (1995), the rapid expansion of mining and exports from Gronigen led to an appreciation of the Dutch *Gelder*, which in turn decreased the output of non-resource sectors such as manufacturing and agriculture.

Evidence for crowding out has often been taken from the cross-country effects of resource development on the performance of exports of manufactured goods (Sachs and Warner 1995, 1999). Stijns (2005) finds in cross-country analysis that higher oil and gas reserves are associated with a smaller proportion of manufacturing in total exports. In a within-country study of Canada, Papyrakis and Raveh (2014) find that oil, gas and mineral production are negatively associated with growth in non-mineral international exports.

Other researchers find no such crowding out. Sala-i-Martin and Subramanian (2013) re-investigate Sachs and Warner's data, and do not find a clear positive or negative association between country resource dependence and manufacturing's share of GDP. Contrary evidence is especially common in within-country studies. Estrades, et al. (2016) find for Uruguay that resource-driven currency appreciation does not significantly affect the output or growth of any sector there. Ito (2017) for oil abundant Russia finds that oil-price shocks that caused appreciation of its real exchange rate did not prevent a slight rise in manufacturing output. More fundamentally, Aragon, et al. (2015) question whether resource-driven currency appreciation will lower growth in GDP over time, rather than merely change its composition, and argue that resource booms may in any case help the development of related types of manufacturing.

For Indonesia in particular, limited regression-based empirical work has been done to test for the effects of resource extraction on manufacturing, but descriptive studies have suggested a benign effect. Usui (1997) finds that an increased share of petroleum in total exports in Indonesia over the boom period 1970-1975 raised the share of manufacturing in GDP. After the oil boom ended in 1975-1982, as the share of petroleum in exports gradually declined, manufacturing's share in GDP rose substantially. Usui argues Indonesia avoided the Dutch disease because it invested its accumulating surplus from oil revenues during the boom period in order to accelerate growth in non-primary tradable sectors, particularly manufacturing. Similarly, looking more recently in the 2000's, Feryawan (2011) argues that the mining sector in Indonesia, especially oil and gas, has generated induced demand that has expanded the country's manufacturing sector.

2.2 Human Capital Investment

Researchers in growth and development generally agree that a country's investment in education is important for long-run economic growth (Barro, 2001). Education is often measured using enrolment rates, years of schooling, or proportions achieving a given standard.[2] An increase in high school enrolment rates, for example, can have a positive effect on productivity and growth in income per capita, and vice versa. The positive effect of education on growth has been found in many studies (Barro, 2001; Hanushek, 2013; Sebastian-Perez and Raveh 2015).

Against this background, some have argued that resource dependence can create adverse incentives for education demand, and thus slow human capital accumulation and long term growth. Gylfason (2001) and Gylfason and Zoega (2006) argue, for example, that natural resource dependence may lower the relative return to individuals from acquiring additional education. Resource extraction sectors in resource-rich countries may provide strong demand and wages for low skilled workers, reducing incentives for young people to continue with schooling required for higher skilled employment in non-resource sectors. A decrease in the number of

[2] Resource curse studies commonly use school enrolment rates (see Davoodi and Zou (1998); Gylfason and Zoega (2006), Carmignani and Chowdury, 2010). and Sebastian-Perez and Raveh (2015).

educated people may then run reduce growth in long run output (Walker 2013; Douglas and Walker 2016; Gylfason 2001).

Gylfason (2001) tests this argument using country level data between1980-1997, and finds a negative correlation between share of natural capital in total capital, and public expenditure on education. Gylfason also shows that having resource wealth can lead to a decline in average years of schooling for girls, and in the level of boys' and girls' enrolment in secondary school. Black, McKinnish, and Sanders (2005) similarly argue that this accounts for why the high school drop-out rate in the Appalachian region in the United States increased substantially during the 1970's coal boom. Douglas & Walker (2016) also find support for an education demand channel for the negative effect of coal mining dependence on growth in Appalachian counties. In particular, they find the effect on high school completion stronger than that on college completion.

In contrast, a few papers have found contrary evidence regarding resource dependence and education, perhaps because resource windfalls can also fund greater education supply. For example, Blanco and Grier (2012) find no significant effect of overall resource dependence on either physical or human capital in 17 Latin American economies. Alexeev and Conrad (2011) find that per capita oil output has a positive and significant effect on primary and secondary school enrolment rates, and a positive association between share of resources in Gross National Income (GNI) and primary school enrolment rates. Similarly, using United States state level panel data, James (2017) finds the enrolment rates in public schools tend to be relatively high in resource-rich states, as do teacher salaries and teacher-student ratios. James also finds a positive association between resource-rich endowments and public spending in education. Using provincial level analysis for China, Wu and Lei (2016) similarly find a positive association between human capital accumulation and resource abundance, with both positively correlated with sustained growth.

For Indonesia in particular, we are aware of one study by Edwards (2016), which finds that the share of mining in district GDP is negatively associated with the enrolment rate of senior secondary school students, though only using single year cross sectional data for 2009.

2.3 Institutional Quality

Most scholars in the broader growth literature recognize the importance of good institutions for growth (e.g. Acemoglu, et al. 2005) and so it is not surprising that resource curse scholars have investigated the effect resource dependence has on institutional quality. "Rentier state" theory predicts that resource wealth from a few large sources makes governments less dependent on taxing their populations, which in turn makes them less accountable to the citizens they govern (Sachs and Warner 1995; Ross 2001; Isham et al. 2005; Gylfason and Zoega 2006; Deacon 2011 and Deacon and Rode 2015). This can result in poorer quality governance and institutions, (the latter meaning rules by which the economy operates as in North (1991)), thus reducing growth. For example, resource rents can enable states to fund repressive regimes which in turn may suppress dissent in ways that increase conflict and lessen incentives for private innovation. Rentier state arguments are often linked with older theories of rent-seeking, which predict that resource-abundant countries will experience a higher incidence of corruption than non-resource-abundant countries.

In support of this negative view, Bulte, Damania, and Deacon (2005) use data from 97 countries and find that countries that have a high share of fuel and mineral exports have lower indicators of rule-of-law and government effectiveness. They find no such association for countries with high shares of exports of more broadly based production, such as agriculture. Similarly, Busse and Groning (2013) use panel data following 129 countries from 1984-2007, and find that an increase in the share of natural resource exports in GDP is negatively associated with the level of perceived corruption.

As with education, however, other studies fail to find that resource dependence lowers institutional quality, or even that the funds made available from resource revenues can improve governance capacity. Alexeev and Conrad (2009) find no significant effect of mining's share of GDP or output per capita on a rule of law index. Similarly, di John (2011) finds little evidence that resource wealth raises corruption. In di John's detailed survey, corruption levels in mineral abundant countries were lower and rose less than in non-mineral countries during the periods 1965-1990 and 1990-2000. In even greater contrast, Brunnschweiler and Bulte (2008) and Brunnschweiler (2008) in cross country analysis find positive and significant effects of total natural capital and sub-soil wealth assets per capita on indicators for rule of law and for government effectivenesss. (This effect was not robust, however, to the addition of controls for initial income.) More recently, Karimu et al. (2017) find resource rents (as a share of GDP) significantly improve public investment, though the strength of effect depends on institutional quality.

As foreshadowed, an alternative hypothesis is that a country's institutional quality is not affected by its resources, but that its pre-existing condition determines whether resources help or hinder growth. Mehlum, et al. (2006) convincingly argue that resources slow the growth of a country's economy if it already has poor quality institutions as reflected by a weak rule of law, a high degree of corruption, or ineffective bureaucracy. "Producer-friendly" institutions translate resource wealth into income growth because they build secure business environments and attract entrepreneurs and investment. By contrast, "grabber-friendly" institutions reward unproductive activities of seeking wealth-transfers, reducing incentives for production. Mehlum, et al. (2006) empirically test this hypothesis by regressing country-level average growth in real GDP per capita from 1965 to 1980 on resource dependence, measured as the share of primary exports in GNP in 1970, along with institutional quality and an interaction term between the two. They find the coefficient of the interaction term is positive, implying that as institutional quality improves, the negative effect of dependence on growth diminishes. This method has subsequently been widely used, for example by Arezki and van der Ploeg (2011), Libman (2013), Bhattacharyya and Hodler (2010) and Oyinlola, Adeniyi, and Raheem (2015).

A rare contrary finding regarding this "contingent curse" hypothesis comes from Brunnschweiler's (2008) cross country study. When Brunnschweiler measures resource abundance as either total natural capital or mineral resource assets, she finds the interaction term term to be negative, while the main effect of resource abundance is positive. This implies that resource abundance spurs growth in countries with the poorest institutional quality, but that the effect is offset as institutional quality improves. In contrast, when Brunnschweiler measures resource dependence as share of exports as Sachs and Warner did, her results are consistent with those of Mehlum, et al. (2006).[3]

As of yet, we know of no previous examination of the effect of resource dependence on institutional quality in Indonesia.

2.4 The Composition of Public Spending from Revenue Windfalls

Under the classical theory of fiscal federalism by Tiebout (1956), local governments may be better informed about local preferences than are central governments, and can thus provide better targeted public spending as needed by local populations. If resource taxes or royalties are transferred back to local governments, as countries such as Brazil and Indonesia have done under fiscal decentralisation, this may improve accountability and public service delivery. Better public spending could in turn spur economic growth.[4]

Among resource curse scholars, Atkinson and Hamilton (2003) are the first to examine whether resource dependence could affect growth through its effects on the composition of public

[3] A contrary finding also comes from Arezki and van der Ploeg (2010), who using cross country analysis from 1965 to 1990 do not find significant evidence of institutions or interaction between institutions and resource dependence affecting growth, using either OLS or IV estimation.

[4] The empirical evidence regarding whether public investments aid growth has found surprisingly mixed results. Davoodi and Zou (1998) using cross-country regression, find a weak negative relationship between public spending and economic growth. Atkinson and Hamilton (2003) regress government expenditure allocation on economic growth using cross-country data in the period 1980-1995. They find negative signs on both government investment and consumption on growth, though neither are significant.

expenditures. They argue that resource wealth may hinder growth when governments make poor (though not necessarily corrupt) use of windfall resource revenues. Cust and Poelhekke (2015) express similar concerns, in particular for capacity-constrained local governments under fiscal decentralisation. Similarly, Collier et al. (2010) argue that government use of revenues generated from resource extraction may be relatively inefficient, as governments of whatever level face less pressure to account for its use it than revenues raised via more broadly based taxation.

Empirically, Bhattacharyya and Collier (2014) use cross country data from both OECD and developing countries from 1970 and 2007, and find that resource rents lower the level of public capital. Likewise, using provincial data from China, Zhan, Duan, and Zeng (2015) find that resource dependence lowers government spending, particularly on education and health care. On the other hand, some papers show positive effects of resource revenues on the size or composition of public spending. Karimu et al. (2017), for example, focusing on resource-rents in 39 Sub-saharan Africa countries between 1990-2013, find that total resource rents are positively associated with government investment. They find that the increase in spending in turn raises economic growth. Likewise, Caselli and Michaels (2013) find within Brazil that municipal oil revenues increase spending in public investment, such as housing and urban development, transportation and education.

It thus appears that resource wealth can bring positive or negative effects on economic growth via the composition of government spending between public investments vs. wasteful consumption (Aragon and Christopher 2014; Aragon, Chuhan-Pole, and Land 2015; Aragón and Rud 2013).

For Indonesia in particular, a descriptive study by Feryawan (2011) finds that resource-rich districts do allocate more public spending (routine or targeted to development) than resource-poor districts, but that this does not lead to measurably better service provision for local residents. However, this study does not perform any econometric analysis to estimate causal effects.

We turn now to explain how we will test for links between resource dependence, our four potential causal mechanisms, and economic growth.

3. Data and Estimation Strategy

Most of the data for this study come from the "Indonesia Data for Policy and Economic Research" (INDO DAPOER) data base published by the World Bank.[5] This data base gathers

[5] See http://data.worldbank.org/data-catalog/indonesia-database-for-policy-and-economic-research.

official government sources such as Susenas (the National Economic Survey), the Indonesia Statistical National Agency (BPS), and the Ministry of Finance. Under the country's move to decentralisation between 1999 and 2004, responsibility for the provision of many public services or goods was passed from the central government to district governments. This move required substantial intergovernmental transfers from the central authority, and a focus on local government expenditures and revenue sources, including shared natural resource rents based on province and district of extraction origin.[6] Some district level data are missing prior to decentralisation, and less so during its implementation (2003-2004), while virtually all series are complete from 2005. Since subsequent key variables for this study are available from 2006 onward, we use 2006 as our base year for initial conditions. A list of variables and their definitions is presented in the Appendix.

We construct four measures of dependence on "mining" (which includes oil, gas, and coal). Following Douglas and Walker (2016) and Papyrakis and Gerlagh (2007), the first is mining's share of total Gross Regional Domestic Product (GRDP) for each district, or MINDEP. Our other three measures capture the dependence of district governments on rents or royalties from mining, as done by Casselli and Michaels (2013), Bjorvatn, et al. (2012), and Cust and Rusli (2016). These are the share of revenues in district budgets from all mining sources (MINREV), the share 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).[7]

For our potential causal mechanisms, size of manufacturing in district GRDP comes from INDO DAPOER and BPS. For education, district high school enrolment rates are available from the Ministry of Education and Culture. Data on capital vs. non-capital spending at district level come from the Ministry of Finance. According to the BPS definition, capital spending comprises all expenses paid to produce tangible fixed assets whose benefit or value continues more than a year. Regarding the quality of district governance or institutions, we were able to access a less comprehensive measure for 2006 to 2015, and a more comprehensive measure for 2010 to 2015. For the former, the Indonesia Audit Investigation Board (or BPK) issues annual audit reports which score each district's ability to manage and produce financial statements to an approriate

[6] Others transfers include general-purpose grants (DAU – *Dana Alokasi Umum*) and special-purpose grants (DAK – *Dana Alokasi Umum*). Districts also generate own-source revenues. For greater detail, see Lewis and Smoke (2017).

[7] 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.

government accounting standard. Scores range from 1 to 4, increasing in compliance.[8] This narrow measure can be thought of as a proxy for capacity. More comprehensively, since 2010 the Ministry of Home Affairs has evaluated and published an annual district government performance index score.[9] This index contains four sub-indicators for (a) compliance with the rules and procedures laid out for local districts in national law; (b) intensity and effectiveness of consultation processes with local residents; (c) transparency in reporting sources of income and its allocation in budget planning; (d) innovation to improve the local region. The overall score ranges from 0 to 4, increasing in quality.

Data sources aside, an obstacle to following districts over time has been the official government policy since 2001 of district "proliferation" (*pemekaran*), pursued to make local 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.[10] We thus follow 390 consolidated districts over time in a balanced panel.

Moving to our empirical estimation strategy, we use a three step procedure. For our first step, we estimate the overall (reduced form) effect of resource dependence on real GRDP per capita using a first difference estimator. Analogous to fixed effects for two periods, first differencing should control for stable but unobserved district characteristics that may also be affecting income, and replicates the method of Hilmawan and Clark (2018), albeit for a slightly shorter difference in time (2007 to 2015) to accommodate subsequent analysis.

$$\Delta LnGRDP_i = \beta_0 + \delta_1 \Delta RD_i + \Delta X'_i\,\beta_2 + \varepsilon_i \quad . \tag{1}$$

$\Delta LnGRDP_i$ is $Ln(GRDP_{i,2015}) - ln(GRDP_{i,2007})$ for district *i*, while ΔRD_i measures the change in resource dependence for district i between 2007-2015 using one of our four alternative measures. The $\Delta X'_i$ are control variables commonly used in the growth literature, such as change

[8] More specifically, 1 = cannot give any opinion; 2 = to some degree acceptable; 3 = performed well/ qualified, with correction(s) needed; and 4 = qualified without any exception. These have been publicly available since 2006, and can be accessed at http://bpk.go.id/ihps.

[9] These scores can be accessed at the Ministry of Home Affairs website (http://otda.kemendagri.go.id/).

[10] The 2003 district list comes from the Ministry of Home Affairs. We exclude the regions of Jakarta (Central Jakarta, West Jakarta, East Jakarta, South Jakarta, Kepulauan Seribu) and the district of Tanjung Pinang. Jakarta is excluded because it is not defined as a district under decentralisation law, while Tanjung district lacks some data.

in the labour force participation rate, the initial level of district population in 2006 (in logs) and the log of initial GRDP per capita in 2006. Initial population is included to control for potential pro-growth effects of economies of scale. We also control for the total number of earthquake events over the 8 year period, along with each district's urban status (DURBAN) and whether it is located on the historically more developed island of Java (DJAVA).

We address the possible endogeneity of ΔRD_i by using two types of instrumental variables in IV-GMM estimation. First, following the general approach of Caselli and Michaels (2013) for Brazil, and Cust and Rusli (2016) for Indonesia, we use the instruments constructed by Hilmawan and Clark (2018) of district resource abundance measures in the 1970's and early 1980's, based on the number of oil and gas fields, and proportion of district areas covered by "first contract" coal extraction agreements between the central government and coal mining companies. These abundance instruments were constructed using historical resource maps released by Bee (1982) and Leeuwen (1994, 2017), mapped to 2003 district boundaries using ArcGIS. Intuitively, subsequent changes in resource dependence at district level may be correlated with initial known resource abundance. Yet since that known abundance was determined by central government or international corporate exploration efforts, it should affect subsequent district level growth mainly through extraction.[11] Our second type of instrument is the difference in physical oil, natural gas, and coal mining production from 2007-2015, again as constructed by Hilmawan and Clark (2018) following Caselli and Michaels (2013) for Brazil, and Cust and Rusli (2016) for Indonesia. The specific instrument we use of each type is customised to each resource dependence measure, and will be tested for relevance and overidentification using tests developed for Stata by Schaffer, Baum, and Stillman (2003).[12]

For the second of our three steps, we estimate the extent to which each potential causal channel is affected by resource dependence:

$$\Delta Manuf_i = \alpha_i + \beta \Delta RD_i + \sigma \Delta X'_i + \varepsilon_i \tag{2}$$

$$\Delta School_i = \alpha_i + \beta \Delta RD_i + \sigma \Delta X'_i + \varepsilon_i \tag{3}$$

$$\Delta Ins_i = \alpha_i + \beta \Delta RD_i + \sigma \Delta X'_i + \varepsilon_i \tag{4}$$

$$\Delta Spend_i = \alpha_i + \beta \Delta RD_i + \sigma \Delta X'_i + \varepsilon_i \tag{5}$$

[11] Indonesia's national government had limited fiscal and technological capacity for exploration prior to the 1980's, but had entered into production-sharing agreements with multinational companies.
[12] For MINDEP and MINREV, we use historic abundance in all of oil, gas and coal, and change in production of all three. For OILGASREV, we use oil and gas' historic abundance and change in production levels. For COALREV, we use coal's historic abundance and change in production.

The dependent variables are the change between 2007 and 2015 for district i in its size of manufacturing ($\Delta Manuf_i$), high school enrolment rate ($\Delta School_i$), assessed institutional quality using our longer-running narrower measure (ΔIns_i), or proportion of spending on capital ($\Delta Spend_i$). The resource dependence measures and other controls are as (1), as are the instruments for potential endogeneity. To the extent that resource dependence has been found to positively affect growth in Indonesia, and assuming each channel positively contributes to growth, we expect the coefficient on ΔRD_i in each of equations (2)-(5) to be positive.[13]

To put our (narrow) ordinal institutional quality measure in first difference form, we begin by treating it as cardinal. Subsequently, we reanalyse (4) by collapsing change over time to the three possible categories "improved", "stayed same" or "worsened," and use ordered probit. We do this with or without instruments using the IV-Probit under Conditional Mixed Process (CMP) module in Stata provided by Roodman (2009).

For our third step, we return to (1) to regress the change in real GRDP per capita on ΔRD_i as before, but now adding the four potential causal channels simultaneously:

$$\Delta LnGRDP_i = \beta_0 + \delta_1 \Delta RD_i + \delta_2 \Delta Manuf_i + \delta_3 \Delta School_i + \delta_4 \Delta INS_i + \delta_5 \Delta Spend_i + \Delta X'_i\, \beta_2 + \varepsilon_i \quad (6)$$

As before, all changes are between 2007 and 2015 with 2006 as a base year where needed, and instruments are tried for ΔRD_i.

Together, these three steps should enable us to test the extent to which the overall resource effect on growth experienced by Indonesia is operating via any of the four potential causal channels. The coefficient on ΔRD_i in (1) indicates the total reduced form effect of resource dependence on growth. The coefficients on ΔRD_i in equations (2) to (5) of step 2 indicate the extent to which resource dependence is affecting these potential causal channels. Finally, the coefficients on the four channels in equation (6) of step 3 should indicate the extent to which each affects growth, whether their movement is caused by resource dependence or other influences. The coefficient on ΔRD_i in (6) should in turn reveal the residual effect of resource dependence on growth not explained by the four channels.

Finally, we test the auxiliary "contingent curse" hypothesis that the good or bad effects of resource dependence depend on pre-existing institutional quality. The main approach we report is to use 2006 district institutional quality as a benchmark to rank and separate the 390 districts between the 195 with highest and lowest measured quality. We then re-estimate equation (1)

[13] We do not estimate (2)-(5) using Seemingly Unrelated Regression because the same control variables are included in each equation.

separately for the two samples to test if resource dependence raised growth for the initially stronger districts, and lowered it for the weaker ones. We repeat this exercise using the better but shorter duration institutional quality measure using the base year 2010.

Secondarily, we follow Mehlum, Moene, and Torvik (2006) in retaining the whole sample of districts, and re-estimating (1) with the addition of a measure of institutional quality, and an interaction term between dependence and institutional quality. We would expect the interaction term to be positive if the blessing of resource dependence is increasing in prior institutional quality. Again we try this with both institutional quality measures.

4. Empirical Results

Summary statistics in difference form (2007 to 2015) are reported in Table 1, just as they will be used in regressions. The average change in real GRDP per capita (in logs) over the eight years is a hefty 0.373 (meaning 45.2 per cent), with a high 0.340 standard deviation of the change. Change in resource dependence over this time was small on average, but with large variation between districts both up and down. For example, the largest rise in mining's share of GRDP was 79.3 percentage points over these eight years. The largest rise in district government revenue dependence was 23.9, 36.6 and 25.6 percentage points for oil/gas, coal, and all mining, respectively. On average, Indonesian districts became slightly more resource dependent over this time as measured by share of local government revenues from oil and gas, or from mining overall.

Focusing on the four candidate transmission channels, the real GRDP from manufacturing rose on average over the 8 year period by 460 billion rupiahs (IDR)[14], though with substantial variation across districts with rises and some falls. The high school enrolment rate grew substantially, by 16.29 percentage points on average. The (narrow) Institutional Quality measure rose sharply on average, again with considerable variation. Note that with audit scores from 1 to 4, differences could range from -3 to +3. Finally, the share of local government spending on capital fell slightly on average over this time, again with considerable variation across districts.

4.1 Step One Results

Table 2 presents the overall effect of our four alternative resource dependence measures on real per capita GRDP, both without instruments (models (1), (2), (3) and (4)), and with

[14] As of July 31st 2015, 10000 IDR = 0.739 USD, at which this increase would translate to USD 34 million.

Table 1. *Descriptive Statistics*

Variable	Obs	Mean	Std. Dev.	Min	Max
Δ Real GRDP per capita (in logs)	390	0.373	0.340	-0.876	2.603
ΔMining Dependence	390	0.012	0.139	-0.613	0.793
ΔMining Revenue Dependence	390	-0.012	0.085	-0.507	0.257
ΔOilGas Revenue Dependence	390	-0.027	0.088	-0.619	0.240
ΔCoal Revenue Dependence	390	0.015	0.046	-0.060	0.366
Earthquake	390	0.464	0.936	0.000	7.000
ΔLabour force participation rate	390	0.067	0.114	-0.133	0.415
GRDP per capita, 2006 (in logs)	390	3.958	0.697	1.961	7.609
Population, 2006 (in logs)	390	5.834	1.016	2.534	8.324
DURBAN	390	0.208	0.406	0.000	1.000
DJAVA	390	0.303	0.460	0.000	1.000
# Oil and Gas Fields	390	0.154	0.660	0.000	7.000
% Area with Coal Deposits	390	3.660	14.327	0.000	94.214
ΔOil production (thousand barrels)	390	-165.588	3304.062	-22034.380	51931.340
ΔGas production (MMBTU)	390	2767.066	33453.220	-336333.700	382843.900
ΔCoal land rent and royalties (billions IDR)	390	61.194	483.250	-3692.962	5614.593
ΔShare district spends on capital	390	0.001	0.099	-0.307	0.452
ΔInstitutional Quality (narrow)	390	1.167	1.054	-2.000	3.000
ΔNet enrolment ratio	390	0.163	0.119	-0.172	0.617
ΔManufacturing (10's of trillions of IDR, inflation adjusted)	390	0.046	0.159	-0.654	1.926
InsQual06 (narrow)	390	2.510	0.845	1.000	4.000
InsQual10 (broad)	383	2.468	0.423	0.686	3.240

Note: Detailed definition and variable source are given in the Appendix.

instruments using Generalized Method of Moments IV-GMM (models $(1'), (2'), (3')$ and $(4')$). In this and all tables that follow, model (1) refers to share of mining in GRDP (MINDEP), while models (2)-(4) refer respectively to the share of government revenues from oil and gas (OILGASREV), coal (COALREV), or both combined (MINREV). Looking first at instrument validity tests, Kleibergen-Paap rank F statistics range from 9.046 for model $(2')$ to 12.266 and 16.081 for columns $(1')$ and $(3')$, indicating sufficient strength.[15] Hansen J statistics for over-

[15] An F statistic equal or greater than 10 is commonly acceptable as a benchmark to evaluate instrument strength (Staiger & Stock, 1997).

Table 2. Resource Dependence and real per capita GRDP

Independent Variables	(1) OLS	(1′) GMM	(2) OLS	(2′) GMM	(3) OLS	(3′) GMM	(4) OLS	(4′) GMM
ΔMining Dependence	0.678***	1.539***						
	(0.191)	(0.483)						
ΔOilGas Revenue			0.0385	1.119**				
			(0.384)	(0.494)				
ΔCoal Revenue					0.672	-0.642		
					(0.583)	(0.699)		
ΔMining Revenue							0.211	1.032***
							(0.272)	(0.381)
Earthquake	-0.028**	-0.025	-0.030**	-0.0276**	-0.027**	-0.032***	-0.029**	-0.0219**
	(0.013)	(0.019)	(0.012)	(0.011)	(0.012)	(0.012)	(0.012)	(0.011)
ΔLabour force partic.rate	0.226	0.237	0.232	0.322*	0.262	0.196	0.261	0.379**
	(0.174)	(0.174)	(0.166)	(0.176)	(0.187)	(0.182)	(0.171)	(0.155)
GRDP per capita, 2006 (in logs)	-0.116***	-0.099***	-0.136***	-0.076	-0.156***	-0.121***	-0.131***	-0.104***
	(0.031)	(0.037)	(0.034)	(0.047)	(0.033)	(0.037)	(0.030)	(0.034)
Population, 2006 (in logs)	0.011	0.022	0.005	0.026	0.008	0.002	0.008	0.025
	(0.022)	(0.019)	(0.024)	(0.021)	(0.024)	(0.024)	(0.024)	(0.019)
DURBAN	0.049	0.073*	0.040	0.026	0.058	0.026	0.041	0.045
	(0.043)	(0.043)	(0.043)	(0.050)	(0.044)	(0.046)	(0.044)	(0.043)
DJAVA	0.083*	0.140**	0.032	-0.025	0.042	0.027	0.028	-0.009
	(0.047)	(0.064)	(0.043)	(0.043)	(0.042)	(0.042)	(0.042)	(0.039)
Constant	0.723***	0.551***	0.860***	0.542***	0.904***	0.837***	0.826***	0.628***
	(0.138)	(0.175)	(0.166)	(0.168)	(0.160)	(0.162)	(0.151)	(0.140)
Kleibergen-Paap rk F stat		12.266		16.081		14.164		9.046
Hansen J Stat, p-value		0.4228		0.2910		0.9786		0.1824
Endog test, p-value		0.1195		0.0491		0.0079		0.0597
Observations	390	390	390	390	390	390	390	390
R-squared	0.156	0.045	0.088	0.031	0.094	0.070	0.091	0.054

Notes: Dependent variable is Δ Real GRDP per capita (in logs).Year difference is 2007 to 2015. Instruments used are each district's historical resource abundance in the 1970's and the 1980's and the change in physical resource production for oil, natural gas, and coal. Standard errors are in parentheses. *, **, *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.

identification have p-values in all models $(1')-(4')$ well above levels that would reject the null of exogenous instruments. Hausman-type tests regarding whether each resource dependence measure is exogenous reject this null in models $(2')-(4')$ at the 5% level, and are near borderline at the 10% level in model $(1')$, suggesting that our resource dependence measures are endogenous. We will therefore emphasize the IV GMM models $(1')$ to $(4')$.

Moving to results, we confirm the findings of Hilmawan and Clark (2018) for slightly different years that within Indonesia, resource dependence has positively contributed to growth in per capita income. Taking model $(2')$ as an example, a standard deviation (0.0883) increase in the change in oil and gas dependence is associated with a (=0.0883 * 1.119 = 0.098) 9.8 per cent increase in growth between 2007 and 2015. We find similar positive effects for dependence of GRDP on mining, or government revenue dependence on all mining sources combined. The sole exception is for government revenue dependence on coal, where there is no significant effect on per capita GRDP. Also from Table 2, we find that baseline 2006 GRDP per capita is robustly negatively associated with subsequent growth, suggesting convergence of district incomes.

4.2 Step Two Results

We turn next to test the extent to which resource dependence affects our four candidate mechanisms. Table 3 provides our results, again for each alternative resource dependence measure, with and without instruments. For brevity, the Table reports only the key coefficients on resource dependence and diagnostic tests, for each candidate mechanism in turn (equations (2) – (5) from Section 3).[16]

Starting with validity checks for our instruments, Kleibergen F statistics for both size of manufacturing and high school enrolment rates show in general strong correlations between instruments and resource dependence, with F values above 10, or nearly 10 in all cases (Staiger and Stock (1997)). Hansen J Tests of overidentification for manufacturing and enrolment ratios similarly yield p-values well above rejection that the instruments are uncorrelated with the relevant error terms. With valid instruments, tests for endogeneity of resource dependence for both causal candidates fail to reject exogeneity in models $(2')-(4')$, but reject it at the 10% level for model $(1')$ with p-value of 0.0397 for manufacturing and 0.0529 for enrolment rates). Thus for both causal candidates our preferred specifications are models $(1')$ and (2)-(4).

[16] Full regression tables are available in a supplementary appendix.

Table 3. Resource dependence and four potential causal channels of growth

VARIABLES	(1) OLS	(1′) GMM	(2) OLS	(2′) GMM	(3) OLS	(3′) GMM	(4) OLS	(4′) GMM
Candidate 1: Dependent Variable ΔManufacturing output								
ΔMining Dependence	0.081	0.319^{*}						
	(0.053)	(0.184)						
ΔOilGas Revenue			0.378^{***}	0.385^{**}				
			(0.119)	(0.167)				
ΔCoal Revenue					-0.594^{***}	-0.710^{*}		
					(0.209)	(0.367)		
ΔMining Revenue							0.183^{**}	0.255^{**}
							(0.073)	(0.122)
Kleibergen-Paap F stat		12.266		16.081		14.164		9.046
Hansen J Stat, p-value		0.2525		0.2404		0.5448		0.1938
Endog test, p-value		0.0397		0.2079		0.7551		0.1325
Candidate 2: Dependent Variable ΔNet Enrolment Ratio for students in high school								
ΔMining Dependence	0.119^{***}	0.381^{***}						
	(0.044)	(0.119)						
ΔOilGas Revenue			0.190^{***}	0.302^{***}				
			(0.064)	(0.106)				
ΔCoal Revenue					0.102	0.206		
					(0.137)	(0.229)		
ΔMining Revenue							0.198^{***}	0.282^{***}
							(0.060)	(0.099)
Kleibergen-Paap F stat		12.266		16.081		14.164		9.046
Hansen J Stat, p-value		0.3768		0.2775		0.7943		0.3757
Endog test, p-value		0.0529		0.3041		0.5978		0.5067
Candidate 3: Dependent Variable ΔInstitutional Quality								
ΔMining Dependence	0.700^{*}	2.499^{***}						
	(0.404)	(0.889)						
ΔOilGas Revenue			0.986	2.195^{**}				
			(0.698)	(1.003)				
ΔCoal Revenue					2.667^{***}	5.051^{***}		
					(0.967)	(1.936)		
ΔMining Revenue							1.583^{***}	3.208^{***}
							(0.585)	(0.629)
Kleibergen-Paap F stat		12.266		16.081		14.164		9.046
Hansen J Stat, p-value		0.0665		0.0982		0.0730		0.0615
Endog test, p-value		0.1681		0.2110		0.1954		0.0726
Candidate 4: Dependent Variable ΔShare of public spending on capital								
ΔMining Dependence	0.059	-0.066						
	(0.042)	(0.140)						
ΔOilGas Revenue			-0.069	0.015				
			(0.085)	(0.149)				
ΔCoal Revenue					0.453^{**}	0.343		
					(0.182)	(0.283)		
ΔMining Revenue							0.058	0.001
							(0.082)	(0.128)
Kleibergen-Paap F stat		12.266		16.081		14.164		9.046
Hansen J Stat, p-value		0.1269		0.4936		0.0291		0.1079
Endog test, p-value		0.440		0.4757		0.7665		0.7246

Notes: Year difference is 2007 to 2015. Instruments used for all resource dependence measures are district historical resource abundance in the 1970's and the 1980's and the change in physical production for oil, natural gas, and coal. The full results for each causal channel including the other control variables are available in a supplementary appendix. Standard errors are in parantheses. *, **, *** refers to statistical significance at the 10%, 5%, and 1% levels, respectively.

Instrument validity test results are almost as strong for regressions regarding public capital spending. Almost all of the Kleibergen F values and Hansen J p-values are high, with the exception of exogeneity of the instrument being rejected for coal revenue dependence $(3')$. Tests whether resource dependence is exogenous for capital spending regressions do not reject it in any model. Thus OLS results (1)-(4) should be valid for all four models.

Our instruments do not perform quite as well, however, for institutional quality. Kleibergen F values indicate they remain correlated with our four measures of resource dependence, but Hansen J p-values are smaller, ranging between .06 and .10. This suggests the instruments may be correlated with the structural error terms in institutional quality regressions, and thus not be exogenous. Only if we use the stricter 5% significance level do the four models fail to reject instrument exogeneity. Using these instruments, the exogeneity of our resource dependence measures can be rejected for model $(4')$ only, at the 10% level. This implies that for institutional quality, OLS is valid for models (1), (2) and (3), while IV-GMM results are preferable for $(4')$.

Moving to the findings, in general, rising natural resource dependence is positively associated with most of the four channels investigated, both in OLS and IV-GMM regressions. Beginning with manufacturing, we find that three of our four preferred resource dependence specifications $((1'),(2),(4))$ are positively associated with the size of manufacturing output, with the marked exception of coal revenue dependence (3), which is negative and significant. For example, using model (4), a standard deviation (0.085) increase in the change in mining's share of local government revenues between 2007 and 2015 is associated with a modest increase of (0.085*0.183 = 0.0155) 155 billion IDR (USD 11.45 million) in manufacturing output.

Similarly for high school enrolment, we find it is increased by three of our four preferred resource dependence specifications $((1'),(2),(4))$, with the exception again being government coal revenue dependence (3). For example, from $(1')$ a standard deviation (0.139) increase in the change in the share of mining in GRDP raises the enrolment rate of students in high school by (0.139 * 0.381 = 0.0525) 5.25 percentage points.

In contrast, we find the least evidence that resource dependence has a positive effect on the share of government spending on capital. Only the preferred specification for coal revenue dependence, (3), has a significant effect, which is positive. There, a standard deviation increase (0.046) in the change in coal's share of government revenues increases the share of local government spending on capital by (=0.046 * 0.453 = 0.0208) 2.08 percentage points.

Table 4. Resource Dependence and Institutional Quality: Ordered probit with and without instruments, marginal effects

Dependent Variable: Change in Institutional Quality (improved, same, worsened)								
Variable	(1)	(1′)	(2)	(2′)	(3)	(3′)	(4)	(4′
ΔMining Dependence	0.779 (0.560)	2.397 (2.210)						
ΔOilGas Revenue			1.256 (0.886)	0.613 (0.775)				
ΔCoal Revenue					6.033*** (2.189)	12.002** (0.011)		
ΔMining Revenue							1.986** (0.834)	2.601 (1.905)
Observations	390	390	390	390	390	390		
Wald Chi2	24.71		26.52		31.69		31.06	
Prob > Chi2	0.0009	0.0000	0.0004	0.0000	0.0000	0.0000	0.0001	0.0000
Pseudo R2	0.0495		0.0490		0.0560		0.0548	
LR chi2		104.72		291.48		254.65		239.64
Log likelihood		21.64		290.35		529.69		280.65
Atanhrho Endog, p-value		0.469		0.737		0.123		0.713
Instruments p-value (1st stage regression)								
- Oil & gas abundance		0.000		0.000				0.000
- Coal abundance		0.102				0.000		0.000
- Oil production		0.001		0.000				0.000
- Gas production		0.040		0.000				0.002
- Coal production		0.428				0.000		0.000

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

Marginal Effects

	Worsened		Stayed same		Improved	
Variable of interest	M.E	P value	M.E	P value	M.E	P value
ΔMining Dependence	-0.036	0.184	-0.198	0.165	0.235	0.162
ΔMining Revenue	-0.093	0.047	0.501	0.018	0.595	0.017
ΔOilGas Revenue	-0.059	0.178	-0.320	0.159	0.379	0.156
ΔCoal Revenue	-0.281	0.051	-1.527	0.005	1.809	0.006
Observations	390		390		390	

Note: M.E is marginal effect

We deal lastly with institutional quality, because of its ordinal nature. We assume first, as in Table 3, that auditor assessment scores are cardinal. Using this simpler approach, we find as with manufacturing and high school enrolment that three of our four preferred resource dependence specifications ((1), (3) and (4′) but not (2)) are positively associated with institutional quality. This is contrary to the prediction of the rentier state hypothesis that resource dependence degrades institutional quality. Taking the example of column (4′), a standard deviation (0.085) increase in the change in mining's share of government revenue increases the auditor's index score of district financial reporting by (=0.085*3.208=0.273) .273 score units.

We move second to recognizing the ordinal nature of audit scores by constructing ordered changes, where district government financial reporting is assessed as having improved, stayed the same, or worsened between 2007 and 2015. We use ordered probit estimation with and without instruments, which we report in Table 4. Note that with the CMP Oprobit module in Stata provided by Roodman (2009) we can test instruments for first stage weakness but not over-identification. With instruments found to be strong in first stage regressions, *atanhrho* p-values do not reject exogeneity of resource dependence in all four models, making models (1)-(4) preferable. Here, resource dependence is significantly positively associated with institutional quality in two of four specifications (3) and (4) and not significant in the remaining two ((1) and (2)). The marginal effects for the non IV models are reported at the bottom of Table 4. From model (4), for example, an increase in mining's share of local government revenues from 0% to 100% increases the probability of institutional quality improving over time by 59.5 per cent, and decreases the probability of it worsening by 9.3 per cent.

To summarize our Step 2 results, we find evidence that three of four resource dependence measures are positively contributing to the size of the manufacturing sector, the high school enrolment rate, and to improvements in institutional quality when the latter is treated as cardinal. We also find some evidence resource dependence raises institutional quality if it is treated as ordinal (for two of four dependence measures relating to share of government revenues), and limited evidence that higher resource dependence raises the share of public spending on capital (one of four dependence measures only). In only one of 16 cases did we find a negative association, between government coal revenue dependence and size of manufacturing.

We move next to test the extent to which these potential causal mechanisms actually cause growth in per capita income in Indonesia, and the extent to which they can collectively account for the overall positive effect we find of resource dependence on growth.

Table 5. Resource dependence, causal channels, and real per capita GRDP

Independent Variables	(1) FD1	(1′) IV	(2) FD3	(2′) IV	(3) FD4	(3′) IV	(4) FD2	(4′) IV
ΔMining Dependence	0.595***	1.414***						
	(0.174)	(0.512)						
ΔOilGas Revenue			-0.118	1.030**				
			(0.364)	(0.490)				
ΔCoal Revenue					0.492	-0.502		
					(0.604)	(0.710)		
ΔMining Revenue							0.0224	0.967**
							(0.255)	(0.390)
ΔManufacturing output	0.277	0.0875	0.335	0.0337	0.345	0.270	0.322	0.0685
	(0.219)	(0.170)	(0.231)	(0.151)	(0.233)	(0.221)	(0.229)	(0.158)
ΔNet enrolment ratio	0.014	-0.161	0.124	-0.048	0.107	0.137	0.112	-0.0598
	(0.149)	(0.165)	(0.145)	(0.152)	(0.151)	(0.149)	(0.144)	(0.148)
ΔInstitutions	0.0390***	0.0294**	0.0471***	0.0365**	0.0445***	0.0481***	0.0462***	0.0360**
	(0.0148)	(0.0148)	(0.0157)	(0.0151)	(0.0160)	(0.0157)	(0.0155)	(0.0143)
ΔPublic spending on capital	0.531**	0.316*	0.595**	0.470**	0.564**	0.593**	0.598**	0.432**
	(0.232)	(0.186)	(0.257)	(0.224)	(0.266)	(0.247)	(0.259)	(0.196)
Earthquake	-0.0292**	-0.0287	-0.0289**	-0.0293**	-0.0271**	-0.0309**	-0.0292**	-0.0238**
	(0.0133)	(0.0185)	(0.0119)	(0.0122)	(0.0120)	(0.0120)	(0.0120)	(0.0114)
ΔLabour force partic.rate	0.204	0.187	0.198	0.288*	0.234	0.174	0.213	0.332**
	(0.172)	(0.170)	(0.162)	(0.166)	(0.183)	(0.176)	(0.168)	(0.145)
GRDP per capita, 2006 (in logs)	-0.158***	-0.129***	-0.188***	-0.109**	-0.194***	-0.163***	-0.180***	-0.133***
	(0.0324)	(0.0408)	(0.0340)	(0.0474)	(0.0352)	(0.0386)	(0.0313)	(0.0347)
Population, 2006 (in logs)	-0.00315	0.0187	-0.0112	0.0233	-0.00837	-0.00403	-0.00943	0.0217
	(0.0261)	(0.0197)	(0.0290)	(0.0214)	(0.0284)	(0.0265)	(0.0288)	(0.0192)
DURBAN	0.0747*	0.0866*	0.0781*	0.0523	0.0846*	0.0676	0.0741*	0.0682
	(0.0431)	(0.0448)	(0.0405)	(0.0491)	(0.0431)	(0.0436)	(0.0424)	(0.0433)
DJAVA	0.0586	0.116*	0.0177	-0.0299	0.0182	0.00365	0.0127	-0.0209
	(0.0457)	(0.0670)	(0.0429)	(0.0419)	(0.0417)	(0.0425)	(0.0414)	(0.0394)
Constant	0.914***	0.689***	1.068***	0.646***	1.071***	0.943***	1.032***	0.726***
	(0.203)	(0.202)	(0.240)	(0.201)	(0.230)	(0.228)	(0.228)	(0.171)
Kleibergen F stat		10.893		12.926		14.541		8.165
Hansen J, p-value		0.3463		0.2059		0.3340		0.1168
Endogeneity, p-value		0.1872		0.0472		0.0903		0.0610
Observations	390	390	390	390	390	390	390	390
R-squared	0.204	0.104	0.154	0.086	0.157	0.143	0.154	0.100

Notes: Dependent variable is Δ Real GRDP per capita (in logs).Year difference is 2007 to 2015. Instruments used for all resource dependence measures are each district's historical resource abundance in the 1970's and the 1980's and the change in physical production for oil, natural gas, and coal. Standard errors in parentheses. *, **, *** statistically significant at 10%, 5%, and 1%, respectively.

4.3 Step Three Results

Table 5 reports results where the four candidate transmission channels are added to the first step regressions of Table 2. Regarding instruments, Kleibergen F values range from 9.08 to 13.81 across our four dependence measures, with 3 of four cases above 10. High Jansen J p-values indicate that exogeneity of the instruments again cannot be rejected at any conventional level. With valid instruments, the exogeneity of our resource dependence measures can be rejected at the .10 level or better in all cases as before, suggesting IV-GMM specifications $(1')$ to $(4')$ are preferable.

Turning to the results, we check first whether the candidate transmission channels are in fact positively associated with per capita GRDP within Indonesia between 2007 and 2015. Across all resource dependence measures, growth in real manufacturing output has a positive sign, but is not significant. Similarly a rise in high school enrolment rates has a positive or negative sign across models, but is never significantly associated with growth.[17]

Skipping to our fourth candidate, the share of district public spending on capital is significantly positively associated with local economic growth in all four IV-GMM models. For example, from model $(2')$, a standard deviation (0.099) increase in the change in the share of government spending on capital increases per capita income between 2007 and 2015 by (0.099 * 0.470 = 0.046) 4.6 per cent on average. However, since the share of public spending on capital was not itself raised by resource dependence in step 2, this would suggest that resource dependence cannot be credited as acting through this channel to raise growth.

Our strongest findings relate to our third candidate, institutional quality. From Table 5, this is also found to be robustly positively associated with economic growth. Taking model $(2')$ as an example, a standard deviation (1.054) increase in the change in the audit opinion score increases real per capita income by (=1.054*0.0365 = 0.037) 3.7 per cent. Given that rising resource dependence was found to increase institutional quality in step two for most resource dependence measures, this would suggest that institutional quality is the most likely candidate of our four to be acting as a causal channel through which resource dependence is raising economic growth in Indonesia.

[17] Surprised by this result, we also tried giving higher enrolment rates more time to affect GRDP by using only the change in high school enrolment rates between 2007 and 2011 in otherwise identical specifications of Table 4. Again, we found that in no model were enrolment rates significantly positively associated with growth.

Finally, by examining the fall in the coefficient on resource dependence between Tables 3 and 5 when the four candidate channels are added, we can ask to what extent the latter account for resource dependence's overall positive effect on growth. Unfortunately, it appears our four candidates explain little of resource dependence's positive effects. The overall coefficient falls by 8.1% for GRDP dependence model $(1')$, from 1.539 to 1.414. It falls by 8.0% for oil/gas revenue dependence model $(2')$, and by 6.3% for total mining revenue dependence model $(4')$. Thus, although institutional quality is shown both to be raised by resource dependence, and in turn to raise GRDP per capita, neither it nor the other 3 candidate factors collectively can account for most of the positive effect resource dependence has had on growth in Indonesia in the years following decentralisation.

4.4 Testing the Contingent Curse Hypothesis

We test finally the synthesis hypothesis of the resource curse literature that resource dependence aids growth for jurisdictions who already have good institutions, but harms it for those who do not. We test this hypothesis using both a split sample strategy, where we re-estimate Step One regressions for two equal sized samples of districts, sorted by prior institutional quality in a 2006 base year *Ins06*, and also by re-estimating Step One regressions for all districts combined, but adding a control for prior 2006 institutional quality *Ins06*, and an interaction between that prior quality and (change in) resource dependence. For brevity, we focus here on our split sample results, though we find consistent results using the interaction term approach.[18] We measure institutional quality using first the narrower measure available for all years, with the base year *Ins06*, and second the more comprehensive measure with a 2010 base year, *Ins10*.

Tables 6 and 7 provide our results for the narrower measure, using OLS and IV-GMM, respectively. We begin with validity tests for our historical abundance and change in physical production instruments in Table 7. For the 195 stronger institution districts, Kleibergen-Paap rank F statistics range from 13.802 to 243.487, while for the 195 weaker districts, the F statistic is low at 1.021 for model $(1')$, but far in excess of 10 for the other three. Thus for all but one case our instruments are strong. Hansen J tests also yield p-values well above .10 in all models, suggesting that the exogeneity of our instruments cannot be rejected. With instruments valid in 7 of 8 cases, we test for exogeneity of each resource dependence measure. Among stronger

[18] Our instruments for resource dependence suffer from some weakness using the second approach, so we emphasize the more flexible split sample approach.

Table 6. OLS Effects of resource dependence on districts with stronger and weaker initial institutions, 2006 base year

	Stronger institutions				Weaker institutions			
VARIABLES	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
ΔMining Dependence	0.0621				1.085***			
	(0.170)				(0.296)			
ΔOilGas Revenue		0.547				-0.409		
		(0.371)				(0.686)		
ΔCoal Revenue			-1.016				0.447	
			(1.112)				(0.654)	
ΔMining Revenue				0.488				-0.187
				(0.357)				(0.423)
Earthquake	-0.00824	-0.00945	-0.00907	-0.00861	-0.0332	-0.0504	-0.0474	-0.0512
	(0.0114)	(0.0105)	(0.0110)	(0.0106)	(0.0333)	(0.0328)	(0.0324)	(0.0331)
ΔLabour force partic.rate	0.793***	0.914***	0.806***	0.903***	-0.00115	-0.137	-0.0920	-0.132
	(0.267)	(0.242)	(0.250)	(0.241)	(0.225)	(0.233)	(0.264)	(0.242)
GRDP per capita, 2006 (in logs)	-0.160***	-0.139***	-0.165***	-0.142***	-0.114***	-0.164***	-0.156***	-0.141***
	(0.0483)	(0.0443)	(0.0485)	(0.0442)	(0.0407)	(0.0518)	(0.0453)	(0.0404)
Population, 2006 (in logs)	0.0306	0.0316	0.0313	0.0310	0.00452	0.00294	0.00679	0.00484
	(0.0294)	(0.0294)	(0.0295)	(0.0295)	(0.0316)	(0.0353)	(0.0349)	(0.0351)
DURBAN	0.0749	0.0581	0.0749	0.0608	0.0998*	0.0729	0.0767	0.0604
	(0.0610)	(0.0581)	(0.0611)	(0.0582)	(0.0593)	(0.0632)	(0.0642)	(0.0654)
DJAVA	0.0993	0.0656	0.0849	0.0739	0.0163	-0.0183	-0.0278	-0.0327
	(0.0601)	(0.0552)	(0.0571)	(0.0546)	(0.0973)	(0.0961)	(0.0930)	(0.0937)
Constant	0.680***	0.620***	0.702***	0.624***	0.765***	1.033***	0.974***	0.944***
	(0.166)	(0.165)	(0.178)	(0.165)	(0.217)	(0.276)	(0.246)	(0.244)
Observations	195	195	195	195	195	195	195	195
R-squared	0.230	0.248	0.231	0.245	0.206	0.073	0.070	0.068

Notes: Dependent variable is Δ Real GRDP per capita (in logs).Stronger and weaker institutions refer to initial level of institutional quality in 2006. Year difference is 2007 and 2015. Standard errors in parantheses. *, **, *** refers to statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7. IV-GMM Effects of resource dependence on districts with stronger and weaker initial institutions, 2006 base year

	Stronger institutions				Weaker institutions			
VARIABLES	(1′)	(2′)	(3′)	(4′)	(1′)	(2′)	(3′)	(4′)
ΔMining Dependence	0.346				3.576***			
	(0.316)				(1.148)			
ΔOilGas Revenue		0.462				1.574		
		(0.291)				(1.079)		
ΔCoal Revenue			0.0996				-0.294	
			(0.834)				(0.784)	
ΔMining Revenue				0.317				1.333**
				(0.244)				(0.657)
Earthquake	-0.00773	-0.00750	-0.00645	-0.00541	0.00293	-0.0395	-0.0517	-0.0305
	(0.0123)	(0.0103)	(0.0109)	(0.0102)	(0.0725)	(0.0323)	(0.0320)	(0.0302)
ΔLabour force partic.rate	0.586**	0.739***	0.767***	0.777***	0.322	0.0311	-0.194	0.122
	(0.259)	(0.184)	(0.241)	(0.175)	(0.271)	(0.278)	(0.246)	(0.254)
GRDP per capita, 2006 (in logs)	-0.155***	-0.151***	-0.164***	-0.167***	-0.0810	-0.0228	-0.130***	-0.0765
	(0.0406)	(0.0448)	(0.0474)	(0.0363)	(0.0543)	(0.0938)	(0.0497)	(0.0504)
Population, 2006 (in logs)	0.0346	0.0312	0.0294	0.0348	0.00734	0.0399	0.0115	0.0413
	(0.0284)	(0.0282)	(0.0288)	(0.0277)	(0.0376)	(0.0308)	(0.0336)	(0.0271)
DURBAN	0.0948*	0.0816	0.0839	0.0974**	0.197***	0.0128	0.0622	0.0419
	(0.0550)	(0.0530)	(0.0592)	(0.0492)	(0.0735)	(0.0813)	(0.0620)	(0.0607)
DJAVA	0.107*	0.0645	0.103*	0.0742	0.134	-0.143	-0.0457	-0.116
	(0.0564)	(0.0494)	(0.0541)	(0.0487)	(0.141)	(0.0939)	(0.0923)	(0.0852)
Constant	0.628***	0.661***	0.693***	0.680***	0.439	0.328	0.873***	0.482**
	(0.163)	(0.162)	(0.174)	(0.154)	(0.324)	(0.362)	(0.257)	(0.245)
Kleibergen-Paap rk F statistics	22.283	13.802	243.487	14.848	1.021	126.197	17.760	64.885
Hansen J Stat, p-value	0.5964	0.3799	0.4427	0.6028	0.6972	0.3990	0.4017	0.4339
Endog test, p-value	0.3780	0.4451	0.0905	0.2787	0.0165	0.0243	0.2778	0.0588
Observations	195	195	195	195	195	195	195	195
R-squared	0.208	0.242	0.228	0.237	-0.531	-0.077	0.059	-0.032

Notes: Dependent variable is Δ Real GRDP per capita (in logs). Stronger and weaker institutions refer to initial level of institutional quality in 2006. Year difference is 2007 and 2015. Instruments used are each district's historical resource abundance in the 1970's and the 1980's and change in physical natural resources production for oil, natural gas, and coal. Standard errors are in parantheses. *, **, *** refer to statistical significance at 10%, 5%, and 1% levels, respectively.

institution districts, we can reject exogeneity only in model $(3')$, while among weaker institution districts, we reject it in models $(1'),(2')$ and $(4')$. The relevant comparisons are thus the coefficients on resource dependence for strong districts (1) on Table 6 vs. weak districts $(1')$ on Table 7, strong districts (2) and vs. weak districts $(2')$, strong districts $(3')$ vs. weak districts (3), and strong districts (4) vs. weak districts $(4')$.

These comparisons (or analogous ones that keep wholly to OLS or IV-GMM specifications) provide no support for the contingent curse hypothesis. The signs on the relevant resource dependence coefficients in our preferred specifications are always positive, and if anything, larger for districts which began with poorer institutional quality in 2006. Taking dependence of district GRDP on mining, for example, the coefficient is 3.58 and significant for weaker districts, but only .06 and not significant for stronger districts. We find a similar difference for district government dependence on coal revenues. It is possible, therefore, that resource dependence has actually been a larger blessing for Indonesian districts who began with weaker institutional quality.

We test next whether this result is robust to using our more comprehensive local governance performance index that is only available since 2010. Tables 8 and 9 provide analogous regressions to those in Tables 6 and 7, but with all differences taken between 2011 and 2015, with 2010 as the base year for institutional quality, population, GRDP per capita, etc.

Again beginning with instrument validity tests for Table 9, Kleibergen-Paap rank F statistics exceed 10 for all but model $(3')$ for both stronger and weaker districts, while p-values of Hansen J tests are well above .10 in all models. Exogeneity of resource dependence is rejected for models $(1')$ and $(2')$ for stronger districts, but not otherwise. Hence, the relevant comparisons are the coefficients on resource dependence for strong districts $(1')$ on Table 9 vs. weak districts (1) on Table 8, strong districts $(2')$ vs. weak districts (2), strong districts (3) vs. weak districts (3), and strong districts (4) vs. weak districts (4).

Only with our more comprehensive institutional quality measure do we find some evidence for the contingent curse hypotheses, but even here it is limited. For no group of districts or resource dependence measure is resource dependence found to negatively affect growth. However, using the dependence of GRDP on mining measure $(1')$, the coefficient on resource dependence is 2.273 and significant at the 10% level for strong districts, compared to -.024 and not significant for weak districts. The effect of oil and gas revenue dependence on growth also appears larger for stronger districts than for weaker ones, though even for weaker districts its

Table 8. FD-OLS Effects of resource dependence on districts with stronger and weaker initial institutions, 2010 base year

	Stronger institutions				Weaker institutions			
VARIABLES	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
ΔMining Dependence	0.0410				-0.0237			
	(0.586)				(0.0974)			
ΔOilGas Revenue		-0.585				0.197**		
		(0.844)				(0.0942)		
ΔCoal Revenue			-0.171				-0.0430	
			(1.392)				(0.252)	
ΔMining Revenue				-0.579				0.197**
				(0.812)				(0.0971)
Earthquake	-0.0232*	-0.0215*	-0.0228*	-0.0216*	-0.0118**	-0.0125***	-0.0115**	-0.0127***
	(0.0127)	(0.0119)	(0.0120)	(0.0120)	(0.00474)	(0.00462)	(0.00482)	(0.00460)
ΔLabour force partic.rate	0.393	0.439	0.399	0.445	-0.106	-0.0991	-0.108	-0.0981
	(0.407)	(0.403)	(0.397)	(0.405)	(0.0679)	(0.0642)	(0.0663)	(0.0644)
GRDP per capita, 2010 (in logs)	-0.00519	-0.0426	-0.00455	-0.0366	-0.0350***	-0.0246*	-0.0345***	-0.0251*
	(0.0353)	(0.0416)	(0.0373)	(0.0365)	(0.0119)	(0.0147)	(0.0123)	(0.0145)
Population, 2010 (in logs)	-0.0642*	-0.0650*	-0.0653*	-0.0667*	0.00195	0.00333	0.00161	0.00327
	(0.0377)	(0.0330)	(0.0343)	(0.0347)	(0.00624)	(0.00600)	(0.00631)	(0.00602)
DURBAN	-0.0373	-0.0135	-0.0386	-0.0178	-0.00686	-0.00834	-0.00610	-0.00743
	(0.0670)	(0.0430)	(0.0658)	(0.0487)	(0.0230)	(0.0224)	(0.0227)	(0.0225)
DJAVA	0.0666*	0.0885*	0.0672*	0.0898*	0.0314**	0.0242*	0.0324**	0.0246*
	(0.0380)	(0.0480)	(0.0386)	(0.0489)	(0.0138)	(0.0137)	(0.0139)	(0.0138)
Constant	0.634**	0.764**	0.638***	0.751**	0.292***	0.249***	0.291***	0.251***
	(0.245)	(0.321)	(0.195)	(0.297)	(0.0568)	(0.0623)	(0.0574)	(0.0617)
Observations	191	191	191	191	192	192	192	192
R-squared	0.035	0.047	0.035	0.048	0.081	0.101	0.080	0.101

Notes: Dependent variable is Δ Real GRDP per capita (in logs). Stronger and weaker institutions refer to initial level of institutional quality in 2010 based on *local governance performance index*. The year difference is 2011 to 2015. Standard errors are in parentheses. *, **, *** refer to statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 9. FD-IVGMM Effects of resource dependence on districts with stronger and weaker initial institutions, 2010 base year

	Stronger institutions				Weaker institutions			
VARIABLES	(1′)	(2′)	(3′)	(4′)	(1′)	(2′)	(3′)	(4′)
ΔMining Dependence	2.273*				0.0949			
	(1.269)				(0.163)			
ΔOilGas Revenue		1.905***				0.258*		
		(0.498)				(0.142)		
ΔCoal Revenue			0.319				0.192	
			(1.814)				(1.977)	
ΔMining Revenue				1.495***				0.238*
				(0.365)				(0.139)
Earthquake	-0.0432	-0.0243*	-0.0212*	-0.0203	-0.0139***	-0.0130***	-0.0119**	-0.0142***
	(0.0276)	(0.0132)	(0.0113)	(0.0126)	(0.00527)	(0.00454)	(0.00493)	(0.00449)
ΔLabour force partic.rate	0.138	0.224	0.379	0.241	-0.127*	-0.0984	-0.102	-0.104*
	(0.499)	(0.390)	(0.392)	(0.387)	(0.0697)	(0.0624)	(0.0689)	(0.0598)
GRDP per capita, 2010 (in logs)	0.0507	0.0980*	-0.0149	0.0388	-0.0467***	-0.0220	-0.0340**	-0.0275*
	(0.0549)	(0.0577)	(0.0353)	(0.0426)	(0.0110)	(0.0154)	(0.0140)	(0.0149)
Population, 2010 (in logs)	-0.0125	-0.0588	-0.0508*	-0.0259	0.00464	0.00386	0.00177	0.00500
	(0.0269)	(0.0380)	(0.0266)	(0.0280)	(0.00697)	(0.00595)	(0.00639)	(0.00589)
DURBAN	-0.0102	-0.103	-0.0131	-0.0241	-0.00814	-0.0110	-0.00807	-0.0132
	(0.0588)	(0.0842)	(0.0528)	(0.0569)	(0.0232)	(0.0221)	(0.0236)	(0.0220)
DJAVA	0.0563	-0.00660	0.0638*	0.00371	0.0347**	0.0207	0.0329**	0.0197
	(0.0404)	(0.0384)	(0.0382)	(0.0350)	(0.0155)	(0.0144)	(0.0152)	(0.0140)
Constant	0.0477	0.259*	0.578***	0.247*	0.319***	0.237***	0.288***	0.253***
	(0.213)	(0.153)	(0.153)	(0.150)	(0.0544)	(0.0659)	(0.0635)	(0.0647)
Kleibergen-Paap rk	2.673	44.835	0.882	41.769	4.478	30.436	0.813	18.940
Hansen J Stat, p-value	0.8022	0.2960	0.5359	0.4960	0.1708	0.5630	0.3224	0.4663
Endog test, p-value	0.0353	0.0551	0.6511	0.2287	0.5156	0.6357	0.8437	0.5926
Observations	191	191	191	191	192	192	192	192
R-squared	-0.191	-0.181	-0.140		0.045		0.077	0.099

Notes: Dependent variable is Δ Real GRDP per capita (in logs). Stronger and weaker institutions refer to initial level of institutional quality in 2010 based on a *local governance performance index*. The year difference is 2011 to 2015. Instruments used are districts' historical resource abundance in the 1970's and 1980's (continuous form) and change in the physical resource production for oil, natural gas, and coal. Standard errors are in parantheses. *, **, *** refer to statistical significance at the 10%, 5%, and 1% levels, respectively.

effect is positive and significant. However, the effect of coal revenue dependence is not significantly different from zero for either stronger or weaker districts. And opposite to the contingent curse prediction, the effect of overall mining revenue dependence is positive and significant for weaker districts, but not significantly different from zero for stronger ones.

In summary, whether with a limited institutional quality (capacity) measure over a longer period, or more comprehensive performance measure over a shorter period, we do not find evidence that rising resource dependence is a curse for districts who begin with weaker quality institutions. Instead, for some measures resource dependence is a stronger aid to growth for districts who begin with weaker institutional quality measures, while in some cases initial quality makes no difference. We do find two cases, however, where resource dependence has stronger positive effects on growth in districts with stronger initial institutions – GRDP and oil/gas revenue dependence, using our more comprehensive measure of local government performance.[19]

5. Discussion and Conclusion

In this paper, we have examined whether the overall positive effect of resource dependence on economic growth in Indonesia found by Cust and Rusli (2016) and Hilmawan and Clark (2018) can be explained by four potential causal channels. These causal channels have figured prominently in the resource curse/blessing literature: 1) spillover effects on the manufacturing sector, 2) effects on education demand or supply, 3) effects on institutional quality, and 4) effects on the proportion of public spending on capital.

Using a three step strategy, we first confirm that resource dependence has been positively associated with growth in real per capital GRDP in Indonesia, for the specific years available for our study. Instrumenting for four alternative resource dependence measures using both historical resource abundance levels and changes in physical production, we find three of four resource dependence measures positively associated with growth. For example, we estimate that a standard deviation increase in the change in mining's share of GRDP between 2007 and 2015 would increase real per capita GRDP by 21.4 per cent over that period.

In our second step, we find evidence (from three of four alternative measures) that resource dependence positively contributes to the size of the manufacturing sector, the high school

[19] Our alternative interaction term approach finds the same lack of support. We find that, whether with narrow or broader institutional quality measures, and with or without instruments, an interaction term between initial institutional quality and change in resource dependence is never positive and significant.

enrolment rate, and to improvements in institutional quality when audit scores are treated as cardinal. We also find some evidence resource dependence raises institutional quality when audit scores are treated as ordinal (for two of four measures), and weaker yet evidence that higher resource dependence raises the share of public spending on capital (in one of four measures only).

While limited work has been carried out on resource dependence's effect on these factors for Indonesia, our positive findings for manufacturing confirm previous descriptive studies by Usui (1997), Asanuma (2008), and Ferryawan (2011). Positive effects may be caused by higher induced demand for resource-related manufactured goods, or by macroeconomic policies dating from Indonesia's 1970's oil bonanza, which protected a number of manufacturing firms deemed to produce nationally strategic products as part of an import-substitution strategy. Another possible explanation is the investment strategy driven by the central government to attract foreign and domestic capital inflows to expand non-resource tradable sectors.[20] This investment strategy has strengthened during the post 2005 decentralisation era, with district governments pressured to find non-resource sources of income to accelerate and maintain development. Those districts receiving greater resource rents may have been better able to attract manufacturing ventures.[21]

Our finding that resource dependence raises high school enrolment rates has not been found previously for Indonesia, but may reflect the fact that, while resource dependence may lower education demand (Black, et al. 2005; Gylfason, 2001), it may also fund an increase in supply in constrained areas. Similarly, our surprising findings about the positive effects of resource dependence on district institutional quality might suggest that resource dependent districts are using the additional rents they receive back from the central government to improve their administrative capacity, perhaps spurred on to do so because of additional incentivized responsibilities assigned to districts under decentralisation (Cust and Poelhekke, 2015).

In our third step, we find that while resource dependence may raise manufacturing, education enrolment, and institutional quality, only the last of these in turn is positively associated with economic growth between 2007 and 2015. Thus, of our four potential causal channels, we find that resource dependence is raising growth only through its positive effects on district institutional quality. That is, districts that receive a greater share of their revenues from resources than others, or who have a higher share of their GRDP from mining, also enjoy higher institutional

[20] This policy is discussed further by Asanuma (2008), Hall Hill (1992), and by Hill, Resosudarmo, and Vidyattama (2008).

[21] As shown in descriptive statistics above, as local district governments have become less dependent on revenues from oil and gas sector, though still not the case for coal, we can see from descriptive number that manufacturing size, on average, has positively changed by 0.046188 (or IDR 461.88 billions or equal to NZD 48 millions) over the past nine years.

quality as assessed by central government auditors. Whether caused by this additional funding, and by other factors unrelated to resource dependence, this higher institutional quality is raising per capita GRDP. This result is consistent with the literature finding that better institutions are strongly associated with better economic outcomes (see for example Acemoglu, Johnson, and Robinson, 2005). While higher capital spending is also associated with higher growth, we find no evidence that resource dependence is boosting such spending. It is also clear that our four potential candidates together account for only a small fraction (6-8 per cent) of the positive effect of resource dependence on growth.

Finally, we find no support for the "contingent curse" hypothesis that has sought to synthesize conflicting findings in the resource curse literature by predicting that resource dependence benefits growth for jurisdictions who already enjoy strong institutions, and reduces growth otherwise. Using either a split sample or interaction approach, we do not find dependence lowers growth for districts who begin with weaker institutional quality. In many cases, we even find the reverse, with dependence having stronger pro-growth effects in districts who began with weaker institutional quality.

Our study is limited by the fact that it is confined to the years after Indonesia's major structural adjustment of decentralisation. We thus cannot be sure how much the benefits of resource dependence and its causal channels owe to the particulars of Indonesia's implementation of decentralisation, with its return of resource-based revenues and public good provision responsibilities from the central government to districts. Nevertheless, in this within-country study of a vast resource-producing developing country, where we carefully address unobserved heterogeneity and endogeneity of resource dependence measures, we find resource dependence raises per capita income, in part by working through funding the improvement of district institutional quality.

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Appendix: Definitions of Variables and Data Sources

Variable	Definition	Source
Δ Real GRDP per capita (in logs)	The natural logarithm of difference of real GRDP per capita: $\Delta\text{GRDP per capita} = ln(\frac{GRDP_{percapita,2015}}{GRDP_{percapita,2007}})$	INDO DAPOER World Bank (see https://datacatalog.worldbank.org/dataset/indonesia-database-policy-and-economic-research) The Indonesian National Statistical Agency (BPS) (see https://www.bps.go.id/)
Earthquake	The number of earthquake events at the district level, 2007-2015	Indonesian National Board for Disaster Management (BNPB). See http://bnpb.cloud/bnpb/tabel1
ΔLabour force partic.rate	The change in labour force participation rate between 2015 and 2007	INDO DAPOER World Bank, BPS
GRDP per capita, 2006 (in logs)	Natural logarithm of initial GRDP per capita in 2006	INDO DAPOER World Bank, BPS
Population, 2006 (in logs)	Natural logarithm of initial population in 2006	BPS
DURBAN	Dummy urban status = 1 if urban districts/municipalities, = 0 if non-urban/rural	Urban status of district/municipality is taken from the Ministry of Home Affairs, the Republic of Indonesia
DJAVA	Dummy Java Island = 1 if the districts are located on Java Island, = 0 otherwise	
ΔMining Dependence	The difference in mining dependence between 2015 and 2007	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia
ΔMining Revenue Dependence	The difference in mining revenue shares, between 2015 and 2007	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia; BPS
ΔOilGas Revenue Dependence	The difference in oil and gas revenue shares, between 2015 and 2007	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia; BPS

Variable	Definition	Source
ΔCoal Revenue Dependence	The difference in coal revenue shares, between 2015 and 2007	Ministry of Finance, Republic of Indonesia; The Audit Board of the Republic of Indonesia; BPS
ΔCoal land rent and royalties (billions IDR)	The change in coal land rents and royalties between 2015 and 2007	Ministry of Energy and Mineral Resources, Republic of Indonesia
OilGas abundance	The number of major and minor oil and gas fields in the 1970's production period in all Island of Indonesia. Each "major" oil and natural gas field is weigted by 1, and each "minor" field by 0.25. For example, if district A has 10 minor oil/gas fields and no major ones, $District_A = 0 + (0.25 \times 10) = 2.5$	Ooi Jin Bee (1982), mapped to 2003 district boundaries using ArcGIS.
Coal abundance	The share of coal deposit areas (shown by first generation coal agreement contract introduced by Leeuwen (1994, 2017)) of total district area.	Leeuwen (1994,2017), mapped to 2003 district boundaries using ArcGIS.
ΔPublic spending	The difference in public capital spending shares 2015 and 2007	Ministry of Finance
ΔNet enrolment ratio	The difference in net enrolment ratio between 2015 and 2007	Ministry of Education and Culture, the Republic of Indonesia
ΔManufact (inflation adjusted, in 10's of trillions of IDR)	The difference in real GRDP of manufacturing sector 2015 and 2007	INDO DAPOER World Bank, BPS
ΔInstitutional Quality	The difference in audit opinion score of each district's financial reporting between 2015 and 2007. The opinion ranges from the worst to the best: cannot give any opinion = 1; to some degree acceptable = 2; perform well/qualified, but corrections needed = 3; qualified without any exception = 4.	The Audit Board of the Republic of Indonesia (www.bpk.go.id)
InsQual06	The initial institutional quality of district in 2006 based on the audit opinion score.	The Audit Board of the Republic of Indonesia (www.bpk.go.id)
InsQual10	The initial institutional quality of district in 2010 based on score of local governance performance index.	The Ministry of Home Affairs of the Republic of Indonesia. (http://otda.kemendagri.go.id/FormMenu/DaftarEKPPD)