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Coal and Mineral and its Impact on Human Development Index: An Empirical Study in South and East Kalimantan Region, Indonesia

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ABSTRACT

This article aims to analyse the effects of coal and minerals on human development index (HDI) in South and East Kalimantan provinces of Indonesia. Historically, Kalimantan was famously known as the largest contributor of coal and mineral production in Indonesia. Under Indonesia's fiscal decentralization policy which effectively ran since 2004, we test: Do revenues from coal and minerals negatively affect HDI? By focusing on nine coal giant areas within these two provinces that have longer mining histories, and linking it with the coal boom event since the 2000's, and using panel data analysis with fixed effects controlled, we find that coal and mineral revenues have a positive effect on HDI, contrary with resource curse hypothesis. The results remain consistent regardless of inclusion of other important covariates such as the past level of institutional quality and net student enrolment ratio, or whether revenues in all non-renewable resources are used. However, the positive impact found is small in magnitude. For example, for every 10% points increase in the share in coal and mineral revenues in local government budgets, HDI increases by 0.0085 points, Ceteris paribus.

Keywords: Coal and Mineral, Mining, Natural Resources, Human Development Index
JEL Classifications: H50, I15, I25, I31

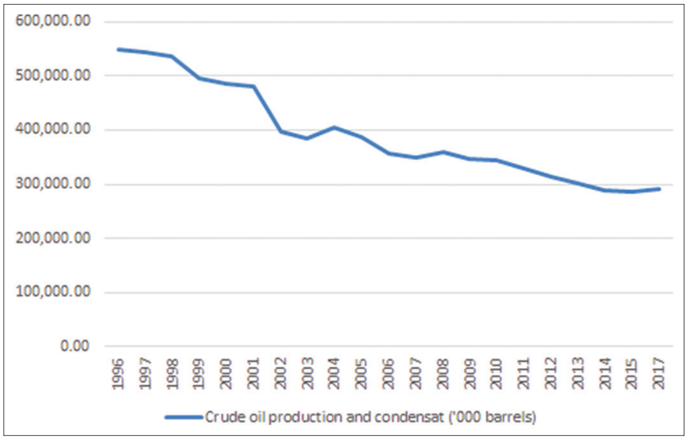
1. INTRODUCTION

Indonesia is known as the largest archipelago country with more than 17,000 islands and at the same time blessed by abundant of natural resources, ranging from forest to energy sector. Regarding with the latter sector, there are three main commodities covering this sector: oil, natural gas, and coal and other minerals. On average, during 1996-2017 period, Indonesia has produced at least 391 million barrels of crude oil, including 2,961,734 MMscf of natural gas, and 218 million tonnes of coal (Central Statistic Agency, Indonesia/BPS, 2017). Despite that, the production of crude oil has faced a gradual decline, with a 2.98% decrease annually on average over the 1996-2017 period (Figure 1).

On the other hand, the trend of coal production in Indonesia increased dramatically between 1996 and 2017, far more productive than the other mineral products (Figure 2). It also showed that production of coal in 2017 has reached 410 million tonnes compared with its production in 1996. The rise in coal production caused by a rapid demand globally for coal-fired power plants has placed Indonesia as the largest coal exporter in the world (Burke and Resosudarmo, 2012). Approximately 74.26% of the total coal production from Indonesia are exported to China, India, Japan and Europe. However, the utilization of coal domestically was only used around 25% from the total production (Figure 3), primarily allocated to support small number of power plants, cement plants, and some other small factories. Therefore, the surplus of national coal production still indicates that coal is the essential commodity for Indonesia's energy security in the future.

East Kalimantan and South Kalimantan provinces are two areas in Indonesia which have contributed largely on the production

Figure 1: Crude oil production in Indonesia (in barrels), 1996-2017



Source: Graph by authors from Indonesia's central statistic agency data. https://www.bps.go.id/statictable/2009/06/15/1092/produksi-minyak-bumi-dan-gas-alam-1996-2017.html

of this resource.[1] Based on the data from Directorate General of Mineral and Coal of the Republic of Indonesia, Kalimantan Island has dominated 80% share of coal, while 20% have been supported by Sumatra Island. Currently, Kalimantan was chosen as the center of production and mineral processing and national energy storages. This stated in the master plan for the acceleration of Indonesian economic development (MP3EI). This fact is interesting to investigate, especially connecting it with the performance of development indicators achieved by regions that have been affected by coal.

In this study we are interested to link whether coal production in South and East Kalimantan Provinces has any effect in fostering development quality in these areas. An influential study by Sachs and Warner (1995) has found that natural resources tend to trap resource-rich countries to have lower economic growth, or worsened quality of institutions, a phenomenon which is called a resource curse. On the contrary, there are studies that find that natural resources can help countries for having better income per capita growth and increased standard of living (household consumption, lower poverty levels) (Ouoba, 2016; Loayza and Rigolini 2016). Attentions now have also shifted to test sub-national resource impact, emphasizing how locals are affected from the activities linked with mining (Manzano and Gutierrez, 2019). Emphasizing on that, in the case of Indonesia, the interesting question to raise here is that do coal and mineral-rich provinces in Kalimantan Island perform worse in terms of their development progress. This question is increasingly important particularly when the decentralization era has been running in Indonesia in 2001 or effectively in 2004.

The structure of the paper is then organised as follows. We summarize a number of relevant literature review in Section II. In Section III, we present the source of data and methods that we use in this case to match it with the purpose of the study. Section IV presents and discusses the main results. Section V summarizes the main conclusions.

1 East Kalimantan in particular has also been selected as the official capital area of Indonesia replacing Jakarta (see https://www.thejakartapost.com/news/2019/08/26/breaking-jokowi-announces-east-kalimantan-as-site-of-new-capital.html)

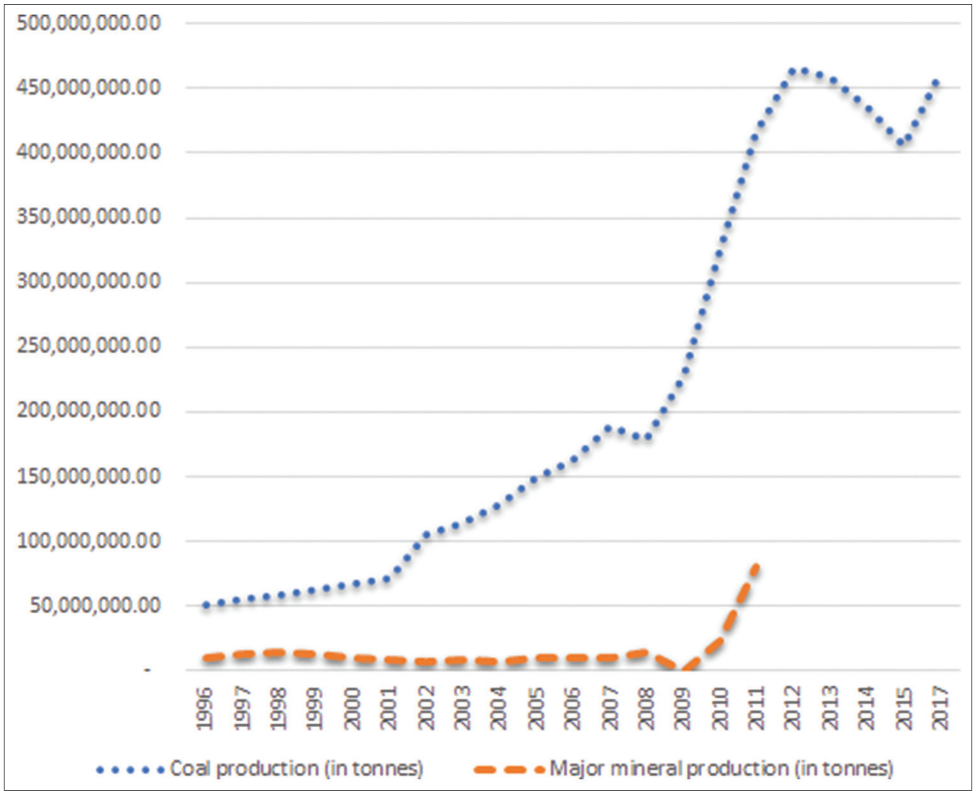
2. LITERATURE REVIEW

The implications of natural resources on economic development have been split into two views (Gilberthorpe and Papyrakis, 2015). Oil and other minerals for example have been seen as a valuable capital that can act as a prerequisite for developing countries to become industrialized nations (Rostow, 1959; McMahon and Moreira, 2014). Despite this view seems to be very logic, natural resource abundance is empirically placed as a factor that hinders nation's development progress due to its adverse effect on income growth or other key development outcomes (Manzano and Gutierrez, 2019). The theoritical literature of the negative link between natural resources and development is known as the resource curse hypothesis (RCH). The RCH explains that countries with abundant natural resources tend to have lower economic growth in the long term compared to those countries that have less natural resources (Sachs and Warner, 1995, 2001; Auty, 2007; Kolstad and Wiig, 2009). The RCH is also expanded to associate the causal effects between resource dependence/abundance and indicators with respect to development such as poverty and human capital (Gylfason, 2001; Ross, 2003; Bulte et al., 2005, Ross, 2015; Gilberthorpe and Papyrakis, 2015).

Empirical investigations, however, have offered some conflicting evidence regarding the effects of natural resources on development indicators. Bulte et al. (2005), for example, investigate the effects of natural resources on indicators such as human development index (HDI) and undernourished population using country level data. By controlling the past level of gross domestic product (GDP) per capita in 1970 and separating measures of natural resource abundance based on non-renewable (point source) and renewable resources (diffuse source resource), Bulte et al. find that point source resource, representing oil and minerals, has a negative and significant effect on HDI, and has a positive impact in rising population with low nutrition. This negative effect, however, dissapears when resource abundance measure is measured using renewable resources (agriculture, etc.), where the coefficients show positive in sign, but insignificant. Moreover, when Bulte et al. control institutional quality based on the rule of law and government effectiveness, the detrimental effect caused by natural resources on HDI is no longer significant, indicating that the effect of resource abundance has worked indirectly through institutional quality.

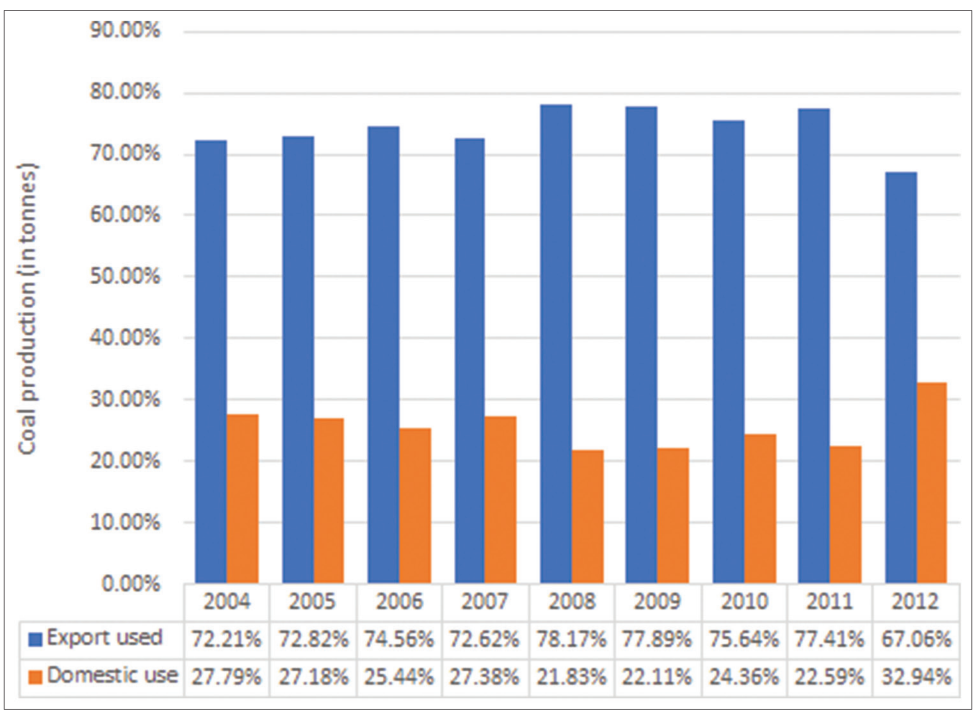
Daniele (2011) has similarly tested direct impact of whether current human development levels, measured using HDI as used in Bulte et al. (2005), have been affected by natural resources in the past. Using regression analysis with ordinary least squares (OLS) and also controlling GDP per capita and institutional quality, as well as using 97 countries cross-sectionally, Daniele finds that the share of metal and fuel in total exports, which seemingly reflect natural resource dependence, is negatively correlated with HDI. Nevertheless, when resource abundance is measured using the stock of natural capital and mineral assets, the effect rather is found to be positively correlated.

Figure 2: Coal production and major minerals (in tonnes), 1996-2017



Source: Graph by authors from Indonesia's central statistic agency data. https://www.bps.go.id/statictable/2009/06/15/1092/produksi-minyak-bumi-dan-gas-alam-1996-2017.html (major mineral includes bauxite, nickel and granite, data fro 2012 until 2017 are not available)

Figure 3: Coal production based on its use (exported and domestic use)



Source: Directorate general of mineral and coal, ministry of ESDM, 2012

At regional level, Caselli and Michaels (2013) recently have done an extensive study across municipality level in Brazil regarding the impact of revenues associated with oil drilled offshore on many aspects of development outcomes. Using OLS and instrumental variable regressions, Caselli and Michaels find that oil revenues improve spending allocations especially for housing and urban development, followed by the rise in expenditures in education and transportation function. Moreover, they also find that oil-related revenues increase education outcomes such as number of teachers and related facilities at school. For example, a rise in oil revenues by approximately a million in 2000 was positively correlated with an increase of three teachers and two classrooms in 2005.

Undertaking non-econometric study, McMahon and Moreira (2014) explore the facts brought by natural resources which contributed on the rapid growth of resource rich countries in the 2000's period. Mineral-dependent low-income and lower-middle-income countries have performed relatively better progress with regards to the health and HDI measure, in particular for the period 2000-2010 and 2007-2012. More specific, McMahon and Moreira also focus on the development progress in Chile, Ghana, Indonesia, Peru and South Africa, given the fact that such countries have long been exposed by mining-based activities. They find that the focused countries have been able to improve and maintain high quality in terms of HDI and, for some countries have experienced increased in higher institutional quality level.

Not directly relevant with HDI, but conducted at the provincial level in Indonesia, Fatah (2008) using the case of South Kalimantan Province finds that coal mining in this province has a small effect on regional economy and labour market locally. Using quantitative analysis based on social accounting matrix method, Fatah finds that an increase in coal mining activities has only absorbed 2% of the workers population regionaly. He also finds that coal mining has generated more revenues for higher income households than for middle and low income households, benefitting the rich rather than the poor. On the contrary, Lahiri-Dutt and Mahy (2008), in their fieldwork study in two locations in East Kutai (East Kalimantan Province), one of the largest coal producing areas in Indonesia, find that coal-based economy has a positive impact on local labour market, especially for women. Examples include positive trickle-down effect such as increased service sector around the mine areas, business related to food catering, and jobs in mining for locals.

Table 1: Definition of variables

Dependent and explanatory variables used		
HDI	=	Human development index, values range between 0 and 100, rescaled from 0 to 1
COALMINERALS	=	Share of mining revenues in regency/municipality budgets
MININGREV	=	Revenues from oil, gas, and coal and minerals transferred in IDR (in logs)
Literacy rate	=	Literacy rate, scaled 0-1
GRDP per capita (in logs)	=	Local gross domestic product per capita (real price, 2000)
Inst_Qual	=	Institutional quality, based on audit investigation score at regency/municipality level
NERjunior	=	Net enrollment ratio of junior education
NERSec	=	Net enrollment ratio of senior school education

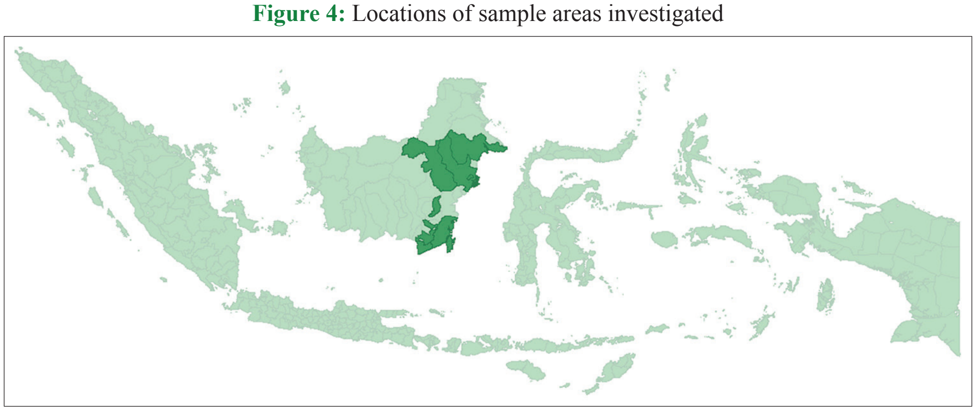
3. DATA AND EMPIRICAL METHOD

To elaborate the main question, we select two provinces in Kalimantan: South and East Kalimantan. We select nine giant coal locations in Indonesia, five regencies in South Kalimantan Province and four regions (three regencies and one municipality) to represent East Kalimantan Province.

We use data mostly from the Indonesian Cental Statistics Agency (BPS). Data related with HDI are taken from the current newly released version of Indonesia's human development publications. This HDI data contain a composite index reflecting human development progress in Indonesia sub-nationally over the period between 2010 and 2018. The index has used a new method for its calculations following United Nation Development Programme formula. In 2010, HDI is no longer measured using literacy rate and GDP per capita. Instead, it has been replaced by the expectation of school years and gross national product (GNP) per capita. However, Indonesia's HDI does not use GNP as no available data regionally exist related with this indicator. The BPS then uses per capita expenditure as a proxy of this measure. Meanwhile, life expectancy is still used for measuring quality of life.

For our key independent variable, data of coal and mineral revenues are taken from Indonesia Central Audit Board (BPK). We use revenues rather than production following Caselli and Michaels (2013). We argue that as Indonesia has implemented decentralization policy, revenues from natural resources can serve as better proxy for coal and mineral dependence measure as it is directly transferred to local government budget periodically per annum and will be used to execute development as programmed. The coal and mineral revenues use audited realization of revenues at regency and municipality levels. Revenues that sourced from

Figure 4: Locations of sample areas investigated



Source: Graphed by author(s)

agricultural, forestry, and fisheries sectors are also informed by BPK's publication, but we only focus on resources that are unrenewable as our main explanatory variable. Regarding with control variables, we follow Bulte et al. (2005) and Daniele (2011). We use local GDP (GRDP) per capita and institutional quality as controls. We also use net enrollment ratio at junior and secondary schools, including literacy rates to accompany.

We then use panel data model as the main analysis in this study. First, we start from a standard method based on pooled OLS under panel data structure to test the effect of natural resources on HDI. Second, we use fixed effects (FE) analysis to remove unobserved effects caused by the use of our sample district that potentially heterogenous. Our reduced form equation is then constructed as follows:

$$HDI_{i,t} = \alpha + COALMINERALS_{i,t-1} + \beta' X_{i,t-1} + \mu_i + \gamma_t + \varepsilon_{i,t} \quad (1)$$

Here, we regress human development index ($HDI_{i,t}$), at current years (2012 to 2018) on the key variable, $COALMINERALS_{i,t}$, in the past year (2006-2012). Here $COALMINERALS_{i,t}$ which is measured as the share of revenues from coal and minerals obtained by regency/municipality in the total government budgets.[2] For robustness, we also use revenues resulted from oil, gas, coal and minerals or $MINIGREV_{i,t}$, as an alternative measure, and we regress HDI on this measure. Note that when we use this second measure, the logarithmic form is used instead of a share form.

The constant region FE are captured by μ_i, while $X_{i,t}$ is a set of vector containing control variables as explained in Table 1, and it also indicates the past years (2006-2012). The subscript $i = 1,2,3,\ldots\ldots,8$ for the 8 regions across South-East Kalimantan islands, and $t = 1,2,3,\ldots\ldots.7$, for the 7 years, making the time series are less than the number of cross-sectional identifier.

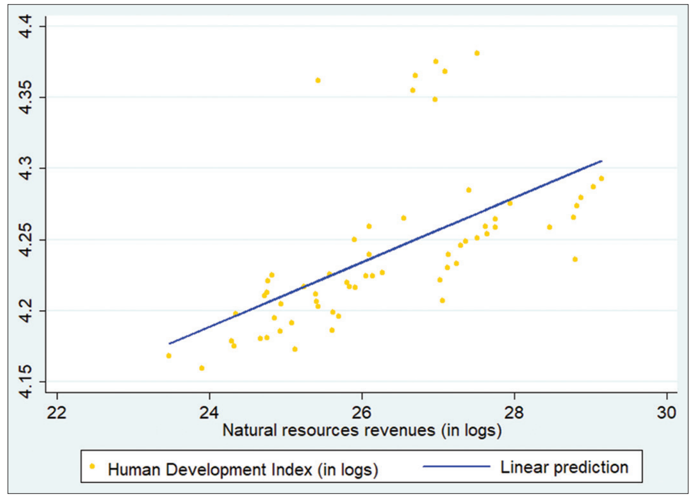
4. RESULT AND DISCUSSION

We begin by describing our selected locations in this study. Indonesia in general has six major island: Sumatra, Kalimantan, Java, Sulawesi, Nusa Tenggara and East Region, and Papua. As depicted in Figure 4, South and East Kalimantan provinces are situated side to side. The regions investigated here are shown in the green dark colour. Figure 5 presents the scatterplot of relationship between mining revenues in the past (2006-2012) and current HDI (both in logarithmic form). As can be seen, the simple correlation shows positive pattern contrary with the RCH. The estimated line of simple regression of natural resources revenues on HDI also shows strong positive effect. This suggests that there may be no adverse effect of natural resources on HDI as postulated in the RCH, though it is too early to conclude as more formal analysis has not been conducted.

In Table 2, we show the results from the share in coal and mineral revenues in regional budget in the past (2006-2012) on HDI in 2012-2018. We first start by depicting results based on pooled OLS in our panel data structure. As presented, we find that in all specifications, coal mineral revenue share has a negative sign but insignificant.

2 As summarised in descriptive statistics (see Appendix 1), my oil dependence measure contains 0 value. This prevents me to transform it in a logarithmic form. Also, as it uses the share or proportions rather than level, it is infrequent to convert it as logs (see Wooldridge, 2016, p.194-195, for detailed explanations).

Figure 5: The correlation between mining and human development index



Source: Authors' calculation

Table 2: Pooled ordinary least squares results of the effect of coal and minerals on human development index

Variable	(1)	(2)	(3)	(4)
Coalminerals	−0.063	−0.041	−0.050	−0.031
	(0.045)	(0.033)	(0.033)	(0.031)
GRDP per capita (in logs)	0.023***	0.007	0.003	−0.003
	(0.004)	(0.005)	(0.005)	(0.005)
Literacy rate		1.224***	1.078***	0.701***
		(0.245)	(0.251)	(0.212)
Institutional quality		−0.009*	−0.009*	−0.010*
		(0.005)	(0.005)	(0.005)
NERjunior			0.093***	
			(0.031)	
NERSec				0.181***
				(0.042)
Constant	0.588***	−0.479**	−0.380*	−0.007
	(0.016)	(0.219)	(0.223)	(0.195)
Observations	62	62	62	62
R-squared	0.236	0.581	0.617	0.687

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

This finding seems supporting RCH as postulated. GDP per capita as control variable is positively associated with HDI as shown in column (1), though become insignificant in columns (2)-(4). Here we find positive effect of literacy rate as desired, and also strong effects found from education enrolment of those students aged at junior and senior high school. The only worry results here are the effects of institutional quality which shows negative signs and significant effect on HDI. Nonetheless, as this model does not control the unobserved effects led by areas (regency or municipality), we then continue our analysis using the same model but implement FE analysis.

Next in Table 3, we present the results of the HDI impact from coal and minerals by allowing the unobserved effects to be controlled. While the negative effects were shown consistent in the previous model without FE, with FE now we find surprising results where all estimated coefficients in our key explanatory variable (Coalminerals) have shown positive impact, statistically significant at 1% level. All controlled variables have also shown the sign as predicted, with the most striking findings here are the positive effect of institutional quality on HDI. GRDP per capita also shows positive and significant effect, though only at 10% level statistically, but now is found in two of four columns used. In particular, taking column (3) as an example, a 1% point increase in a share in coal and mineral revenues in total local government budgets in the past, holding all other factors constant, is estimated to increase current level of HDI by 0.0009 points (=0.085 *0.01), or 0.0085 points if share in coal and mineral revenues increases by 10% points.

Table 3: Coal and mineral effects on human development index

Variable	(1)	(2)	(3)	(4)
Coalminerals	0.115***	0.091***	0.085***	0.090***
	(0.022)	(0.020)	(0.020)	(0.018)
GRDP per capita (in logs)	0.051*	0.045	0.043	0.039*
	(0.026)	(0.024)	(0.024)	(0.020)
Literacy rate		0.204*	0.186*	0.111
		(0.096)	(0.092)	(0.079)
Institutional quality		0.002**	0.002**	0.002***
		(0.001)	(0.001)	(0.001)
NERjunior			0.017*	-
			(0.009)	
NERSec				0.037***
				(0.010)
Constant	0.420**	0.255*	0.268*	0.357**
	(0.131)	(0.122)	(0.128)	(0.107)
Fixed effects	Yes	Yes	Yes	Yes
Observations	62	62	62	62
R-squared	0.706	0.768	0.777	0.799
Number of id	9	9	9	9

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

Table 4: Mining revenues effect on human development index

Variable	(1)	(2)	(3)	(4)
Revenues from natural resources (logs)	0.015***	0.011**	0.011***	0.011***
	(0.004)	(0.003)	(0.003)	(0.003)
GRDP per capita (in logs)	0.036	0.027	0.024	0.020
	(0.041)	(0.027)	(0.023)	(0.024)
Literacy rate		0.335**	0.280**	0.227**
		(0.105)	(0.102)	(0.080)
Institutional quality		0.002	0.002	0.002*
		(0.001)	(0.001)	(0.001)
NERjunior			0.029**	
			(0.011)	
NERSec				0.041***
				(0.009)
Constant	0.125	−0.055	0.004	0.064
	(0.115)	(0.081)	(0.092)	(0.070)
Fixed effects	Yes	Yes	Yes	Yes
Observations	62	62	62	62
R-squared	0.599	0.729	0.760	0.767
Number of id	9	9	9	9

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

For robustness check, we also test whether the positive effect as found in Table 4 may have been correlated positively only for particular type of point source resource, and not all. We then use revenues from oil, natural gas, and coal and mineral obtained by local governments that we focus as our sample, and next we test it on HDI as previously modelled. The results are presented in Table 3. Again, we find similar results where MININGREV is positively correlated, though now the magnitudes of each coefficient are smaller than when we use previous measure based on the share. Similarly, we also find that the sign of the estimated coefficients for institutional quality is still positive, albeit it is only significant in column (4).

Comparatively, as we move from column 1 to 4 in Table 3 and the same for Table 4, we find interesting result that the inclusion of institutional quality variable reduces the positive effect brought by natural resource dependence on HDI. This suggests that natural resources may affect HDI indirectly through institutional quality as emphasized by Bulte et al. (2005). However, given the fact that the positive effect of coal and minerals dependence is still strong when institutional quality is included, especially when only coal and mineral revenue dependence is used, this also demonstrate that both factors play significant role in strengthening HDI.

Our findings in South and East Kalimantan Provinces oppose the RCH that predicts natural resources can have a negative effect on development outcomes. We find strong evidence that HDI is positively affected by coal and mineral-related revenues in the past, or mining-related revenues for broadly measure. Our study supports positive effects of natural resources found by Caselli and Michaels (2013) for the case at municipality in Brazil, and Daniele (2011) who found positive effect of resource abundance on HDI. The positive impact found here also supports the finding from McMahon and Moreira (2014) and Dutt and Mahy in East Kutai district in East Kalimantan Province who find that coal mining has a positive effect on labour market for locals.

5. CONCLUSIONS

In this study, we pay attention on the two largest mining provinces in Indonesia, South and East Kalimantan, focusing on nine locations that historically have been exploited massively by coal production. We use panel data analysis using FE to deal with unobserved invariant effects. We find that HDI is positively affected by coal and mineral revenues in the past based on this regression method. This finding holds regardless of whether we include additional important control variables, such as institutional quality, or when an alternative measure of mining-related revenues is used.

Some limitation arises, however, in this study. First, we only focus on Kalimantan Island whilst Indonesia has about six major islands, or to be specific 34 provinces, or at district level has a more than 500 administrative areas. Further study needs to be conducted in different areas or comparing locational effects (e.g. mining and non-mining areas) for getting holistic picture about human development impact of coal and mineral. Another limitation is that this study only seeks direct impact of coal and mineral and does not investigate causal mechanism through which coal improves HDI. It is very likely that increased coal and mining revenues raises spending related with education or health programmes, speeding HDI quality in the later. Thus, research working this question is worth recommending.

6. ACKNOWLEDGMENTS

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