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DO PLANTATION AS MAIN INCOME INFLUENCE DEFORESTATION?: EVIDENCE FROM THE VILLAGE LEVEL IN KALIMANTAN, INDONESIA

(Apakah pendapatan utama dari perkebunan mempengaruhi deforestasi?: Studi dari tingkat desa di Kalimantan, Indonesia)

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ABSTRAK

Kompleksitas penyebab deforestasi di Indonesia menuntut dilakukannya berbagai penelitian mengenai deforestasi khususnya untuk mendukung kebijakan terkait pengurangan deforestasi. Aspek ekonomi adalah salah satu yang penting untuk diketahui dalam memberikan gambaran tentang deforestasi. Penelitian ini bertujuan untuk mengetahui hubungan antara pendapatan utama penduduk desa dari perkebunan dengan deforestasi. Data panel dari 3260 desa di Kalimantan tahun 2011, 2014 dan 2018 digunakan untuk menganalisa hubungan ini. Jumlah area yang terdeforestasi pada tiap desa merupakan variabel dependen. Variabel independen yang digunakan adalah sebanyak empat belas variabel, dengan variabel utama adalah desa dengan pendapatan masyarakat dari perkebunan yang merupakan dummy variable. Hasil analisis menggunakan model random efek menunjukkan bahwa desa yang pendapatan utama penduduknya dari perkebunan memiliki hubungan positif terhadap deforestasi. Sebanyak sepuluh variabel independen memiliki hubungan yang positif dengan deforestasi. Sedangkan empat variabel independen yang memiliki hubungan negatif adalah penggunaan kayu bakar, kegiatan pembakaran lahan sebelum berladang, industri kecil bukan kayu dan jumlah perusahaan HPH. Rekomendasi dari penelitian ini adalah perlunya didorong pemanfaatan lahan terdegradasi dan tidak produktif untuk dilakukan rehabilitasi sebagai lahan hutan tanaman sehingga dapat menghindari adanya konversi hutan menjadi non-hutan yang berkontribusi terhadap deforestasi.

Kata kunci: Deforestasi, pendapatan dari perkebunan, PBPH hutan Alam, hutan tanaman, rehabilitasi.

ABSTRACT

The complexity of the drivers of deforestation in Indonesia requires various research on deforestation, especially to support policies related to reducing deforestation. The economy is one aspect that contributes to providing an overview of deforestation. This study investigates the relationship between deforestation and village with dominant income from plantation as main commodity. A panel data analysis using data from 3260 villages in Kalimantan in 2011, 2014, and 2018 was analyzed to determine whether plantation as main income affected deforestation. The dependent variable is deforestation in each village. There are 14 independent variables used, with the main variable is villages with main income from plantation as a dummy variable. The results of random effect model show that villages with plantation as main commodity have a positive impact on deforestation. Ten independent variables show a positive relationship with deforestation. Four independent variables show a negative relationship with deforestation, which include the use of firewood, practice of burning land, non-wood small industries, and logging companies (PBPH Hutan Alam). The recommendation of this research is the need to replanting the degraded and non-productive land for the wood plantation areas, thus the conversion of forest into non-forest area can be avoided.

Keywords: Deforestation, income from plantations, logging companies, wood plantations, rehabilitation.

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I. INTRODUCTION

Deforestation is one of the most extensively discussed topics in environmental issue today. Deforestation is the second largest contributor from the anthropogenic sector to increase greenhouse gas emission, which mostly caused by agriculture and expanding forestry activities (Pendrill *et al*., 2019). The drivers of deforestation have been extensively studied in various settings in order to provide recommendations for policymakers (Austin *et al*., 2019; Busch & Ferretti-Gallon, 2017). Moreover, today many countries are struggling to reduce the deforestation rate and increase forest cover. In fact, efforts to reduce deforestation may not effectively stop deforestation, and thus, deforestation still continues and threatens the sustainability of the environment.

Indonesia has the last largest remaining tropical rainforest in the world, but it is under the threat of deforestation. Previous literature states that Indonesia is the country with the highest deforestation rate, surpassing Brazil (Wijaya *et al*., 2015). Forests in Indonesia have a crucial role in managing the global climate. Thus, it is believed that decreasing deforestation in Indonesia can help to reduce the effect of climate change in the global scale (Busch *et al*., 2015).

Indonesia is the fourth country with the highest population in the world. Therefore, the high population in Indonesia requires a high demand for food and agricultural commodities such as rice, sugar, fruits, and cooking oil. However, the land agriculture is limited. Previous studies also suggest that deforestation has a complicated relationship with agriculture land availability (Harahap *et al*., 2017). This situation could be explained by the fact that all of the industrial, commercial, and agricultural sectors need land for their operation. Since the land is scarce and expensive; thus, people are likely to illegally convert forested areas into clear areas that can be used for plantations, industries or agriculture. In the agriculture sector, farmers tend to choose a quicker and cheaper way to increase their yield by adding more agricultural land that converted from forest area.

Both commercial and subsistence agriculture significantly contribute to deforestation (Hosonuma *et al*., 2012). Many studies investigated large scale commercial agriculture such as oil palm plantation and its relationship with deforestation. However, while large scale commercial agriculture and its effect on deforestation have been extensively examined, there are only a small number of studies that investigate the effect of small scale commercial and subsistence agriculture on deforestation (Chan & Sasaki, 2014). Further, the effect of community farming patterns on deforestation, especially at the village level, is still poorly understand.

The drivers of deforestation have been extensively researched in previous literature (Damette & Delacote, 2012; Krishna *et al*., 2017; Wijaya *et al*., 2015). Some factors causing deforestation include illegal logging, land conversion for agriculture and plantation, mining activities, oil palm expansion (Krishna *et al*., 2017; Wijaya *et al*., 2015), forest concession companies (Tjandrakirana, 2006) and the use of wood as cooking fuel in restaurant (Kuhe *et al*., 2017).

Besides the fact that Indonesia has the fourth biggest population, this country also has the third largest forests in the world. Nevertheless, being a developing country, Indonesia is struggling to increasing its economic growth while also reducing poverty. Increasing economic development without harming the sustainability of the environment is a typical challenge for developing countries possessing abundant natural resources (Smajgl & Bohensky, 2013). Not surprisingly environmental degradation and economic growth have a significant relationship (Ewers, 2006). Thus, for instance, it is often hypothesized that developing countries with low development

growth often face higher deforestation rate , and conversely, developed countries with higher development growth are often hypothesized to have lower deforestation rate (Jorgenson, 2008).

Interestingly, in some cases, the relationship between deforestation and economic growth is intertwined. For instance, past research revealed that there was no clear relationship between economic development and deforestation (Bhatia & Cumming, 2020). On the other hand, another study stated that the development agenda causes deforestation (Djaenudin *et al*., 2018; Goers & Lawson, 2012). Thus, more studies are needed in various settings in order to reveal the actual drivers of deforestation, especially in developing countries setting as the drivers of deforestation among countries vary (Arshad *et al*., 2020; Goers & Lawson, 2012).

One of the possible factors that is predicted to contribute to deforestation is the development agenda (Goers & Lawson, 2012). Indonesia is a developing country with many rural, remote, and undeveloped areas. Thus, in order to improve economic development in those areas, the Government of Indonesia has been developing public facilities such as bridges and roads to provide access to remote and, undeveloped areas. However, the development of the infrastructure in some cases brings negative impacts to the environment as forest areas need to be cleared for the construction of roads and bridges, which in turn leading to environmental destruction and loss of biodiversity.

Another key contributor to deforestation in Indonesia is the expansion of oil palm plantation. The palm-oil industry is one of the fastest-growing industries in Indonesia, as Indonesia is one of the biggest suppliers of oil palm products in the world (Obidzinski *et al*., 2012). Oil palm plantations have contributed to Indonesia's export sectors significantly. In 2015, 19,043,783 tons of crude oil palm worth $23,933 billion were exported by Indonesia (Direktorat Jenderal Perkebunan, 2017). Thus, oil palm industries are a vital contributor to Indonesia's revenue (Obidzinski *et al*., 2012). In 2015, the total area of oil palm plantation in Indonesia was about 12.07 million hectares (Direktorat Jenderal Perkebunan, 2017).

The third reason for deforestation in Indonesia is agriculture (Kubitza *et al*., 2018). The agricultural sector is very crucial to Indonesia. For instance, this sector contributes 12.8 percent to 13.5 percent of the national Gross Domestic Product (GDP) in the last five years (United Nations Statistic Division, 2020). The importance of the agricultural sector for Indonesia is also described in the number of people working for this sector. The data from Indonesian Statistic Bureau (Badan Pusat Statistic) of August 2021 showed that 28,33 percent of Indonesia's labor population works in the agriculture, fisheries and forestry sector. The fact that the economic activities surrounding rural areas were also described the high number of people working for the agricultural sector in Indonesia. The job opportunities in rural areas are often scarce, limiting people from having decent jobs. Moreover, the education levels of rural people are often low, and manufacturing services and activities in rural areas are also limited; thus, working in the agriculture sector is the only option they have. The commodities produced by the agricultural sector in Indonesia are very vital for food security in Indonesia.

Apart from land use activities, studies have also found relationship between socio-economic and demographic situation of the community and deforestation (Damette & Delacote, 2012). Factors such as population growth and poverty increase the deforestation rate in tropical countries (Smajgl & Bohensky, 2013); however, higher population growth and density tend to encounter higher deforestation rate

(Damette & Delacote, 2012).

This research investigates the relationship between small scale commercial and subsistence agriculture and deforestation at the village level. This study focused on the effect of plantations as the main income for villagers, with the evidence from the village data in Indonesia. This research was focused only on Borneo Island, Indonesia, and aims to investigate the relationship between deforestation and land use activities for agricultural purposes at the village level.

II. METHODOLOGY

Data of deforestation, land cover change, number of wood companies in every village in Kalimantan island were derived from the shapefile data format (Geographic Information System) provided by the Ministry of Environment and Forestry of Republic of Indonesia. Data of administration border in every village in Kalimantan were derived from shapefile produced by Indonesian Geospatial Agency (BIG). All shapefile data are processed using Arc GIS to obtain tabular data of deforestation, land cover and number of companies in every village.

There are five dummy variables in this study: plantation commodity as the main income of villages' (*dplantationcom*), the use of firewood as cooking fuel (*dcookfuel*), land burning habit before planting (*dlandburn*), small scale non-wood based industry (*nonwoodind*), and ratio of forest to village area (*ratioforest*). The description of the dummy variables and unit measurement are shown in Appendix 1.

A. Dependent Variable

The socio-economic data of the village in the year of 2011, 2014, and 2018 were obtained from Village Potential Data Collection (*Potensi Desa*/ PODES) published by Indonesian Statistic Bureau (BPS) and were used as independent variables. These data provide the socio-economic of 6,821 villages in Kalimantan. Using a panel data, the analysis was conducted in 3,620 villages in Borneo island, with the three years data the total observation are 9,780 observations.

The deforestation is the dependent variable which means the change of forest area into non-forest area permanently. For example, deforestation in 2011, is an area where in 2009 was forest then change into non-forest area in 2011. The total area changes then called deforestation. This study using hectare as the unit of measurement. Total deforestation in 2011 is the summation of the changes of forest into non forest area between 2009 and 2011. Deforestation in 2014 means the summation of changes of forest into non forest area between 2012 and 2014. Deforestation in 2018 means the summation of changes of forest into non forest area between 2015 and 2018. The amount of deforestation for year 2011, 2014, and 2018 was extracted from shapefile data. To get the deforestation data in village level, spatial village administrative data were also used and overlaid with deforestation map. The administrative data were obtained from Geospatial Information Agency of Indonesia (*Badan Informasi Goespasial*). The Arc GIS was used to overlay and calculate the total area of deforestation in each village.

The Ministry of Environment and Forestry produces this land cover data by interpret the Landsat 7 and Landsat 8 satellite images for years of 2009, 2011, 2014, and 2018 in shapefile format (shp.) that consists of land cover change in Indonesia from 2009 to 2018. Land cover are divided into twenty two classes that were developed using methods owned by Ministry of Environment and Forestry Indonesia (Margono *et al*., 2016).

B. Independent Variable

This study used fourteen independent variables from the data of PODES and Ministry of Environment and Forestry, which are plantation commodity as the main

income of villages' (*dplantationcom*), the use of firewood as cooking fuel (*dcookfuel*), land burning habit before planting (*dlandburn*), small scale non-wood based industry (*nonwoodind*), small scale wood based industry (*woodind*), total of village area (*vilarea*), ratio of forest to village area (*ratioforest*), number of logging firms (*loggingfirms*), number of wood plantation firms (*woodfirms*), forest state release to non-forest state (*forrelease*), forest to transmigration area (*transmigration*), the total area of existing paddy fields (*paddy*), total area of existing plantation (*plantation*), and total area of mix agriculture land (*agrifarm*), as shown in Appendix 1.

The main independent variable is dummy variable, which is the village with dominant income from agriculture with commodity plantation. Village with dominant income from agriculture with commodity plantation is assigned as 1, and 0 for otherwise. The hypothesis of this research is that the villages with commodity plantations as their main income have a positive relationship on deforestation because the communities are increasing their income by expanding their plantation areas through converting forests into plantations (The data were extracted from PODES).

Other independent variables from PODES are the use of firewood as cooking fuel (*dcookfuel*). Villages with most of the people using fire wood are assigned as 1 and 0 for otherwise.

The land burning habit before planting (*dlandburn*) is a dummy variable. Villages that the people usually burning the land before planting are assigned as 1 and 0 for otherwise. The data set were extracted from PODES.

The existence of small scale non-wood based industries (*nonwoodind*) in the village is dummy variable. When the villages have this industry, then it is assigned as 1 and 0 for otherwise. The data were extracted from PODES.

The number of small scale wood-based industries (*woodind*) is the number of industry that exist in the village. This number is different in every period of observation. The data set was measure in number. The data were obtained from PODES.

Besides the socio-economic data, the physical characteristic of the village was also employed in this study. The total area of each village (*vilarea*) was measure in hectare. The area of each village was thought to affect the level of deforestation. It is predicted that the smaller the area of village, the higher of the utilization rate of the area. The data were extracted from land cover data by the Ministry of Environment and Forestry.

Ratio of forest to village area (*ratioforest*) was obtained from the land cover calculation divided by total number of the area. In Indonesia, the Ministry of Forestry sets a regulation that each administration area should have a minimum of 30 present area as a forest. It means that if the ratio of the forest to village area more than 30 percent, the local government can utilize the forest area for the development of the village. For instance, the local government could convert some forest area into agriculture area or other land use. This variable of the ratio of forest to village area is a dummy variable. Village with ratio of forest to village area more than 30 percent is assigned as 1 and 0 for otherwise. The data set were extracted from land cover data by the Ministry of Environment and Forestry.

The number of logging firms (*logging firms*) is a very important variable as logging firms is the main actor that usually utilize the forest resources. The hypothesis is that more logging firms in the village will contribute to the more deforestation. This variable was measure in number. The data set were extracted from concession database from the Ministry of Environment and Forestry.

Another important variable is the number of wood plantation firms (*woodfirms*).

This variable was measure in number. The different between wood plantation firms is the method of extraction the forest resources. Wood plantation company clear all the natural forest in their concession and re-planting the area with specific tree species that use to produce pulp for paper making. On the other hand, logging firms exploit the forest by selecting the tree. Only tree with diameter over 30 centimeters that can be harvested to obtain the log. The data set were extracted from concession database by the Ministry of Environment and Forestry.

Some of the forest state area are release to non-forest state (*forrelease*). This variable was obtained from the shapefile database that provide by the Ministry of Environment and Forestry. The measurement is in hectare. This area is different in every village. The hypothesis is this variable have a positive contribution to deforestation. The data set were extracted from forest release database by the Ministry of Environment and Forestry.

Not only release as non-forest area, some of the forest area also released for a specific purpose. For instance, releasing the forest area to transmigration area (*transmigration*). This policy was designed to support the urbanization program as some people from Java Island are transferred to other main islands including Kalimantan. The measurement is in hectare. The data set were extracted from transmigration database by the Ministry of Environment and Forestry.

The total area of existing paddy fields (*paddy*) in the village was also employed in this study. In some village, the area of paddy field may increase in every period of observation. The hypothesis is paddy area have a positive relationship with deforestation. The unit of measurement is in hectare. The data set were extracted from land cover data by the Ministry of Environment and Forestry.

The total area of existing plantation (*plantation*) is the area of plantation commodity. The area may increase or decrease in every period of observation. The hypothesis is that plantation area have a positive relationship with deforestation. The unit of measurement is in hectare. The data set were extracted from land cover data by the Ministry of Environment and Forestry.

The total area of existing mixed agriculture land (*agrifarm*) is the area of mixed commodity for agriculture. The area may increase or decrease in every period of observation. The hypothesis is mixed agriculture land area have a positive relationship to the deforestation. The unit of measurement is in hectare. The data set were extracted from land cover data by the Ministry of Environment and Forestry.

C. Panel Data Model

This study employed a linear panel data model. Based on this model the econometric model in this study can be formulated as follows:

$$\begin{aligned} \boldsymbol{Def}_{i,t} = {} & \beta_0 + \beta_1 dplantationicom_{i,t} \\ & + \beta_2 dcookfuel_{i,t} + \beta_3 landburn_{i,t} \\ & + \beta_4 nonwoodind_{i,t} + \beta_5 woodind_{i,t} \\ & + \beta_6 vilarea_{i,t} + \beta_7 ratioforest_{i,t} \\ & + \beta_8 loggingfirms_{i,t} \\ & + \beta_9 woodfirms_{i,t} \\ & + \beta_{10} forrelease_{i,t} \\ & + \beta_{11} transmigration_{i,t} \\ & + \beta_{12} paddy_{i,t} + \beta_{13} plantation_{i,t} \\ & + \beta_{14} agrifarm_{i,t} + u_i + \varepsilon_{it} \end{aligned}$$

where:
i= represent observe village in Kalimantan (3,260 villages)
t= 2011, 2014, 2018 (period of time)
uit = group or time effect
ε_{it}= error terms
β_0 is the constant intercept parameter estimation , $\beta_1 - \beta_{14}$represent the slope parameter estimation and ε_{it} represent the error term

This study considers three estimation models such as pooled ordinary least square (OLS), fixed effect model, and random effect model. The first OLS model that have a limitation because it ignores unobserved variable (heterogeneity). If the heterogeneity

exists, a fixed effect or a random effect model is better. An incremental F-test, Breusch-Pagan LM test, and Hausman test are conducted to choose the most appropriate model. If a Hausman test rejects the null hypothesis that the regressors are not correlated with error terms, a fixed effect model is preferred to a random effect model. This type of model allows for heterogeneity or individuality among different cross-sections allowing each cross-section to have its own intercept. In short, the intercept may be different for the cross-sections, but it is time invariant that is the intercept remains the same over time. The random effect model appears to be the best approach to interpret the results. The fixed effect would not the best model for this study due to time-invariant variables such as the distance (see Appendix for the detail summary of independent variables).

III. RESULT AND DISCUSSION

The summaries of model estimation analysis using three different models are presented in Appendix 2. This table used plantation commodity as the main income of villages' as the main interest variable (*dplantationicom*). The first column on the left of the table shows the result of pooled ordinary least square (Pooled OLS) shows a 0.01 significance level ($F=121.96$ and $p<0.0000$). It means, all independent variables simultaneously had a significant effect on the dependent variable. The R-square of .1476 means that the independent variables could explain 14 percent of the variation in the total deforestation area, whereas the rest could be affected by other variables such as price of wood, natural disaster, and wood industry capacity. The main dummy variable plantation commodity as the main income of villagers' has a positive and significant effects on the deforestation ($p<15.76$). Almost all independent variables, except the wood industry (*woodind*), had a significant effect on deforestation. Since this model neglects the individual heterogeneity of deforestation across village, which lead to a significant difference in the amount of deforestation by villages. Thus, it is likely that there is a difference in the intercepts or initial volume of deforestation across villages.

The results of the fixed-effect model are in the middle column of Appendix 2. Based on the fixed effect estimation shows that there is a significant fixed effect ($F=50.92$ and $p<0.0000$). This result suggests that the null hypothesis rejected and it can be concluded that the fixed effect model is better than the pooled ordinary least square model (Pooled OLS). The results of variables using fixed effect model show that five variables such as land burn activity, small-scale wood industries, small-scale non-wood industries, transmigration, and paddy field were not significant, while other variables showed the significant result. Fix effect model omits the analysis of variable village area (*vilarea*), because time invariant effect of this variable.

To examine how the village level influences error variance, the random effect model was conducted. The Breusch-Pagan Lagrange Multiplier (LM) test conducted to observe the existence of the random effect. Based on the result of The Breusch-Pagan Lagrange Multiplier (LM) test, the Chi square = 422.70 and $p<0.0000$, which means that the null hypothesis is rejected. This also means that the panel data have a strongly significant random. This random effect model resulted that all variables are substantial except two variables: small wood industries and forest release.

The result of the F test and Breush-Pagan Lagrange Multiplier test showed that both the fixed effect and random effect model are better than the pooled ordinary least square model. However, to determine which model is more significant between fixed effect and random effect, the Hausman test

is conducted. The result of this test showed that Chi square=-264.92. This negative result means the null hypothesis cannot be rejected. In other words, the test failed to meet the asymptotic assumption. Then the result became inconclusive.

Based on the results of the LM test and the Hausman test, this research chose the random group effect model. Unlike the fixed effect model, a random group effect model assumes that error variances differ across entities and individual effects do not correlate with explanatory variables in the model. This random effect model also provides an advantage to include time-invariant variables like distance as an important predictor variable. Previous research on deforestation also choose the random effect model as the best method for analyzing the regression model in deforestation driver study (Tjandrakirana, 2006). The right column in Appendix 2 presents the result of the random effect model at the 0.01 significance level ($F=1339.57$ and $p<0.0000$). The R-square value of 0.1472 shows that this model accounts for 14.72 percent of the total variance in the determinants of village deforestation in Borneo Island.

Based on the results of random effect model, when all of independent variables are zero, the deforestation in each village is estimated to be - 1.448 hectares per year. Furthermore, the deviation is not statistically significant.

The regression results using the random effect method shows that all of the variables have a significant relationship to deforestation except small scale wood-based industries (*woodind*) and the number of forest state release to non-forest state (*forrelease*). The possible explanation for these results is that the small-scale wood-based industries are not using raw materials from the natural forests. Furthermore, the number of forest state release to non-forest state indicate that the forest in the non-forest state are not suddenly converted to non-forest classes.

The plantation commodity as the main income of villagers' has a coefficient of 57.46 at the 0.01 significance level. It means that villages with the plantation commodity as the main income of the villagers have more deforestation for 57.46 hectares, than those villages with non-plantation commodity as the main income of villagers'. Previous research argue that land property rights make farmers willing to put effort into increasing productivity and intensity of their owned land, and hence, reduce the possibility of them expanding their land illegally. This argument may help to explain the result of this research, that when farmers have land property rights and consider as legal by law, they may not consider expanding additional land illegally as it has legal consequences. Thus, ensuring that farmers have land property rights of their land may be one of the possible solutions to reduce deforestation in Kalimantan.

Interestingly, some variables have unexpected results. These variables are the use of firewood as cooking fuel, the habit of burning agricultural land before farming, and the number of logging companies at the village level. The analysis reveals that the use of firewood is a variable that can reduce the rate of deforestation in a village. A possible explanation for this result is that the volume of firewood used for cooking fuel for households is lower than the volume used for restaurants or businesses. Furthermore, in fact, many people in the village in Indonesia harvest firewood from branches or fallen trees. Thus, the firewood was not harvested from the trees from the forest. Thus, this situation could explain the unexpected result that the use of firewood as cooking fuel did not contribute to deforestation.

IV. CONCLUSION AND RECOMMENDATION

A. Conclusion

This research findings show that the plantation commodity as the villagers' dominant income has a positive relationship with deforestation. The analysis reveals that the number of wood plantation firms and forest ratio greater than 30% in every village are the most influential factors that lead deforestation in the villages. Additionally, other factors such as the total administrative area of the village, the total area of transmigration, the total area of rice fields, the total area of plantations and the total area of mix agricultural fields in the village also contributes to deforestation in the villages.

The number of logging firms is a new phenomenon that needs further investigation. Previous research states that the number of logging firms is one of the main causes of deforestation. However, this study shows that logging firms have a negative relationship to deforestation. The negative balance between revenue and cost of production predicted as the main reason of the dormant companies activity. Nevertheless, the cause of the unexpected relationship of timber firms with deforestation needs to be further investigated.

Based on the result presented, there may be some issues that need to be addressed in order to lower deforestation rate in the village level in Indonesia. Furthermore, policy interventions may also be needed to develop in order to solve the behind the drivers of deforestation in village level in Indonesia.

B. Recommendation

Recommendations from this study are proposed below:

1. Wood plantations firms are believed as one factor that contributes to deforestation in Kalimantan. Thus, the Indonesian government should take an action and policy to reduce deforestation caused by wood plantation firm industries. To avoid the conversion of the pristine forest into plantation forest, only abandoned land and degraded natural forests could be used for plantation forests. Many benefits could be gained from replanting abandoned land and degraded natural forests into plantation forest. For instance, replanting abandoned land and degraded natural forests with trees producing raw materials will provide very high added value to the economy nationally and regionally.
2. Some of the reported cases of forest fires in Kalimantan mention that fires come from land burning by farmers. Many of the previous studies discuss that forest fires contribute to deforestation. However, such studies focus more on forest fires by the large companies, and only small number of research focused on finding the contribution of land burning by farmers to deforestation. Thus, future research should be developed to investigate the effect of land burning by farmers to deforestation. This recommendation is supported with the unexpected result of this study that the habit of burning fields before farming has a relationship to reduce the amount of deforestation. The result shows that the relationship of the land burning by farmers and deforestation is intricate, and thus, need further investigation in the future.

However, there is a limitation of this research. This study was conducted by desk research to analyze the existing data of land cover by the Ministry of Environment and Forestry. Therefore, future research should be completed with field work to enrich the data and information. Furthermore, the field work will also allow the researchers to conduct interviews to get the complete information about land use habit and habit.

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Appendix 1. Description of independent variables and measurement (*Deskripsi dari independen variabel dan unit ukur*)

Acronym	Descriptions	Unit Measurement
dplantationcom	plantation commodity as the main income of villages'	Commodity plantation=1, otherwise= 0
dcookfuel	the use of firewood as cooking fuel	Using firewood=1, otherwise=0
landburn	land burning habit before planting	Burning=1, otherwise=0
nonwoodind	small scale non-wood based industries	Existing industry=1, otherwise=0
woodind	small scale wood based industries	Firms/year
vilarea	total of village area	Ha/year (constant)
ratioforest	ratio of forest to village area	Ratio more than 30 percent=1, otherwise=0
loggingfirms	number of logging firms	Firms/year
woodfirms	number of wood plantation firms	Firms/year
forrelease	forest state (Kawasan hutan) release to non-forest state (APL)	Hectare
transmigration	forest state release to transmigration area	Hectare
paddy	the total area of existing paddy fields	Hectare
plantation	the total area of existing plantation	Hectare
agrifarm	total area of mix agriculture land	Hectare
Def	Total deforestation area	Hectare

Appendix 2. Panel data model for deforestation in village level in Kalimantan (*Data panel untuk deforestasi pada tingkat desa di Kalimantan*)

	(1)	(2)	(3)
Variables	OLS	Fixed Effect	Random Effect
dplantationicom	48.71***	83.33***	57.46***
	(15.76)	(22.07)	(16.40)
dcookfuel	-154.4***	-179.4***	-153.1***
	(15.24)	(16.54)	(14.35)
dlandburn	-70.11***	-16.91	-59.63***
	(16.85)	(21.70)	(17.09)
nonwoodind	-31.78**	-23.48	-27.04*
	(15.41)	(18.87)	(15.47)
woodind	4.603	0.378	3.893
	(3.131)	(4.252)	(3.232)
vilarea	0.00549***		0.00534***
	(0.000324)		(0.000386)
ratioforest	359.0***	3,254***	383.4***
	(27.85)	(204.5)	(32.60)
loggingfirms	-29.67***	186.5***	-24.98**
	(10.25)	(35.55)	(11.92)
woodfirms	197.2***	223.3***	195.6***
	(12.64)	(29.18)	(14.27)
forrelease	0.0848***	-0.103***	0.0242
	(0.0157)	(0.0171)	(0.0152)
transmigration	0.219***	0.105	0.168**
	(0.0695)	(0.0738)	(0.0668)
paddy	0.0909***	-0.0265	0.0834***
	(0.0228)	(0.0447)	(0.0253)
plantation	0.0667***	0.101***	0.0697***
	(0.00369)	(0.00835)	(0.00416)
agrifarm	0.0212***	0.0237***	0.0229***
	(0.00332)	(0.00420)	(0.00336)
Constant	20.61	-1,216***	-1.448
	(21.48)	(87.15)	(23.27)
F-test (Model)	121.96***	50.92***	1339.57***
R-squared	0.1476	0.0923	0.1472
Group Effect Test, LM		2.11***	422.70***
Hausman Test			-264.92
Rho			0.216
N	9780	9780	9780

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1