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# Apakah laju pertumbuhan jalan berkontribusi terhadap deforestasi di Indonesia?

Does the growth of roads contribute to deforestation in Indonesia?

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**Abstrak.** Studi ini menganalisis pengaruh pertumbuhan jalan terhadap laju deforestasi di 33 provinsi di Indonesia selama kurun waktu 8 tahun (2006-2013). Analisa data panel diterapkan untuk menganalisis apakah keberadaan pembangunan jalan mempengaruhi tingkat kegiatan ekspansi pertanian oleh petani yang pada akhirnya menentukan tingkat deforestasi. Laju deforestasi digunakan sebagai variabel terikat, panjang jalan digunakan sebagai variable serta PDB sector pertanian, populasi, upah buruh, total biaya produksi pertanian, indeks harga pangan, dan anggaran infrastruktur jalan digunakan sebagai variabel control. Hasil studi menunjukkan bahwa pertumbuhan jalan berkontribusi signifikan terhadap hilangnya kawasan hutan atau deforestasi di Indonesia. Pembangunan jalan menjadi magnet penggerak untuk perubahan dinamis tutupan hutan karena memfasilitasi pertukaran antara kegiatan bisnis ekonomi, pengurangan biaya untuk produksi pertanian dan memicu pembangunan jalan yang tidak resmi. Dengan kondisi ini, petani mempunyai kecenderungan untuk meningkatkan produktivitas lahan mereka melalui perluasan pertanian ke arah hutan yang pada akhirnya kondisi ini memperburuk ancaman dan tekanan yang sudah dihadapi oleh hutan.

*Kata Kunci: Biaya Transportasi; Deforestasi; Ekspansi Pertanian; Jalan; Pembersihan Lahan*

**Abstract.** This study investigates the effect of roads growth toward the deforestation rate in 33 provinces in Indonesia from eight years period of time, 2006-2013. A panel data analysis was utilized in order to analyze whether the existence of roads development affected the level of agricultural expansion activity by farmers which

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eventually determine the level of deforestation. Deforestation rate was set as the dependents variable and the length of roads was set as independent variable, while agriculture GDP, population, labor wage, budget of infrastructure, the price of crops and cost of agriculture production were set as control variable. The results show that growth of roads significantly contributes to loss in forest area or deforestation in Indonesia. Roads development become a driving magnet for forest cover dynamic changes since it is facilitate trade-off between economic activities and environmental damage, the reduction of agriculture production cost and the emerging unofficial roads building. Having this condition, farmers are eager to enhance their land productivity through agricultural expansion toward the forest and thereby this condition exacerbates the threats and pressure on the forest.

*Keywords*: *Agricultural Expansion; Deforestation; Land Clearing; Roads; Transportation Cost*

## 1. Introduction

Deforestation in tropical countries has been considered by many scholars as one of disastrous environmental problems [1-5]. There has been much concern for deforestation, not only in terms of environmental aspects such as climate change and global warming, but also in terms of economic aspects such as loss of state revenue. For example, during deforestation in the period of 2006-2015, the Indonesian Government lost their revenue due to illegal logging which reached approximately Rp499,507,000,000,000 [6]. In addition, it is found that the total cost from forest land conversion and degradation in Indonesia is equal to 4% of Gross Domestic Product (GDP) [7].

Many research findings show that geophysical factors, demographic and socioeconomic aspects as well as government policies are the prominent causes of deforestation. From all deforestation determinants, almost major studies emphasize the dynamic relation between the building of road and the loss of forest area. Many studies indicate that road building leads to deforestation since it intensifies the pressure on forest resources and reduction of forest cover [8-11]. As a result, the development of roads near forested areas which was implemented in many tropical developing countries was believed to trigger deforestation [12].

In Indonesia, roads have become an integral and essential part of economic growth and development. In addition, road development also aimed at overcoming any socioeconomic issues that often arise [13]. This includes poverty alleviation to zero or 0.02 percent by 2045, dropping the income gap to an ideal level by 2035, and equitable regional development by encouraging higher growth in the eastern part of Indonesia. The policy and purpose of road development in Indonesia were set forth in the National Medium-Term Development Plan (NMDP) of 2010–2014 issued by the Indonesian Government [14]. In addition, the portion of roads development as part of infrastructure project has increase in year 2018 where the budget allocated for this purpose rise up to Rp410,700,000,000,000 that intended for equitable development and improved connectivity [15].

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Regarding the implementation of the National Medium-Term Development Plan (RPJMN) of 2010–2014, the Indonesian Government has implemented several road projects in many regions. During the period 2015–2017, road development in Indonesia has been enormous. Based on data from the Ministry of Public Works and Public Housing (PUPR), the total length of new roads being built reached 2,623 km which comprises 1,286 km of roads having been built in 2015, 559 km of roads built in 2016, and 778 km being targeted to be completed in 2017 [16]. Moreover, based on State Budget and Expenditure (APBN) 2018, the development of roads expected to reach the length around 865 km [15]. Although massive road development built simultaneously in order to support economic growth and welfare equality among Indonesian people, there are concerns associated with the infrastructure development in Indonesia. Those concerns arose because the intensive road development as a part of the national development planning might create a polemic (e.g. land acquisition) in Indonesia. [17].The growth of roads during 8 years period (2006-2013) can be seen in Figure 1 below.

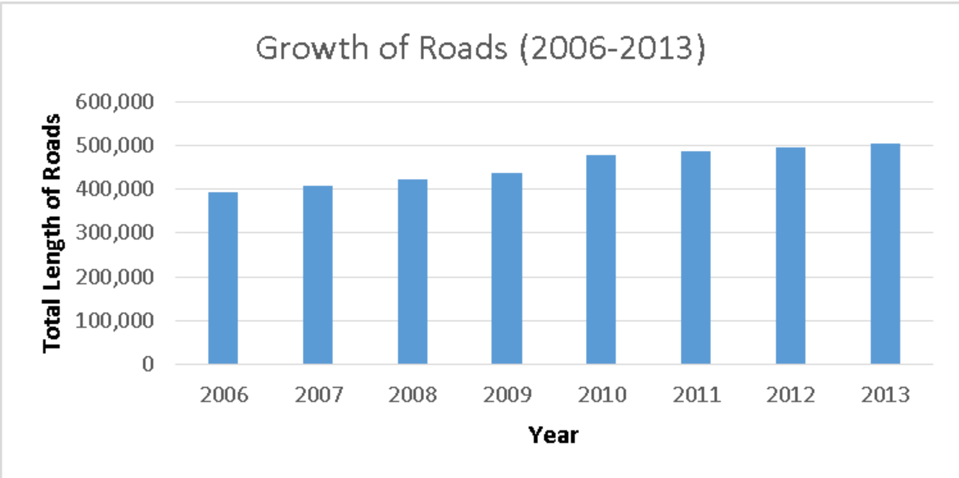


**Figure 1.** Growth of Roads in Indonesia for the period 2006–2013 [18].

The polemic related to roads building in Indonesia emerged since the integration of this kind of project was not fully accommodate by the law of spatial planning in Indonesia [19]. The insufficient transparency of land allocation procedures, stakeholder involvement in permit issuance, and overlapping responsibility in land use management were three factors that contribute to this condition. Consequently, this polemic will induce conflicts and dispute between land stakeholders in Indonesia and eventually might lead to unsustainable land use management and practices as can be seen in the case of agriculture expansion (oil palm plantations) and land infrastructure [20]. Although land use allocation especially for roads development was designated to support economic development; however, this development was also suspected will became a threat for forest areas since it facilitates the land conversion through non-sustainable land use management [21-24].

Since land use competition in Indonesia is quite intense while the land availability is relatively constant, very rapid land conversion might occur. From time to time, the land condition in Indonesia has been modified by people for various uses. For instance, forests

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are converted into agricultural land, settlements, and plantation. In relation to this, a forest resource assessment conducted by the Food and Agricultural Organization (FAO) for the period 2000–2010 shows that the rate of deforestation in Indonesia is alarming as it has reached an average of 498,000/Ha/year [25]. Higher rates of deforestation indicate dynamic land conversion, which in this case might related to forest conversion into other purposes, for example, conversion of forest for the purpose of road construction. The rate of deforestation in Indonesia can be seen in Figure 2 below.

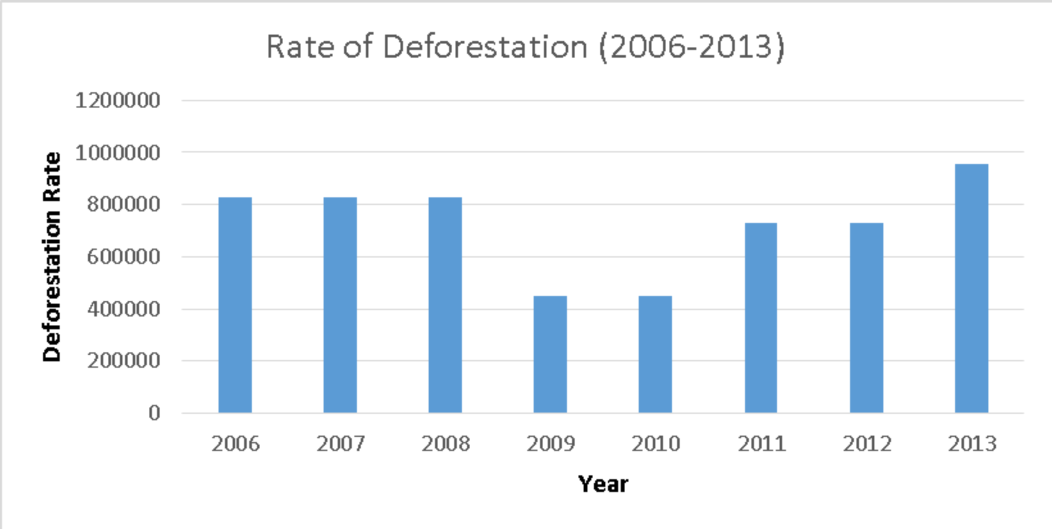


**Figure 2.** Rate of Deforestation in Indonesia for the period 2006–2014 [26].

Obtaining comprehensive information concerning the impact of road construction on deforestation in Indonesia is essential. Several studies focusing on factors of deforestation in Indonesia [27-29] or studies on the impact of roads [30-32] have been conducted. However, these studies only investigate the causes of deforestation in Indonesia in relation to socioeconomic issues and the impact of roads in economic development and poverty alleviation. To date, there have been few studies on the impact of roads on the loss of forest area. Therefore, specific research concerning the effect of road growth on deforestation is required to obtain a more comprehensive understanding of this issue. Based on above explanation, this study will focus on examining the impact of roads growth toward deforestation in Indonesia. To narrow down the scope of the study, the following research question is formulated “Does the growth of road contribute to deforestation in Indonesia?”

The objective of this study is to investigate whether there is a relationship between road growth and the decline in forest area (deforestation). In order to achieve the objective, this research hypothesized that during an eight-year period, the rate of forest loss (deforestation) would increase in line with road growth from year to year. The findings of this study will be useful for the central and local government agencies responsible for the planning of roads development and will provide recommendations for the making of forestry and public work policies in the effort to tackle deforestation in Indonesia.

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## 2. Methods

### *2.1 Data*

In this study, sample data from 33 provinces in Indonesia during eight years period (2006–2013) employed. To measure whether the growth of roads contributes to the changes of forest land, deforestation rate was set as a dependent variable and seven variables were set as independent variables. These variables consisted of length of road, cost of agricultural production, off-farming wage, infrastructure budget, price of crops, agricultural GDP and population. The absolute values of dependent variable, explanatory variable, and control variable were transformed into log values. The interpretation for this model is that at certain percentage, changes in Y were affected by percentage of changes in X [33].

The deforestation rate was defined as the alterations of land use from forest to non-forest occurring in 33 provinces in Indonesia during the period of eight years (2006–2013). The data of deforestation rate obtained from the Directorate General of Forestry Planning, Ministry of Environment and Forestry, and were calculated in hectare.

Length of road was defined as the kilometers of roads built per province for the period 2006–2013 in 33 provinces in Indonesia. The length of road data was derived from the Center for Statistics Agency [34], and was expected to have a positive relationship with deforestation. A study by Angelsen and Kaimovitz [35] showed that construction of new roads or improvement of the condition of existing roads would open remote or new areas and facilitate farmers or people's access to forest area by reducing transportation cost. Thus, the migration of people to new area will lead to emerging new settlement and economic activities which then resulted in forest land being cleared.

Population was defined as the number of population for each square kilometer area (km2). The data of population density from 33 provinces in Indonesia for the period of 2006–2013 were obtained from the Central of Statistical Agency and calculated in per km2. Population was expected to have a positive relationship with deforestation. This was based on the results of a study by Cropper et al. [36], which shows that the total forested area cleared for agricultural production was determined by the household demand in terms of agricultural land, and this condition was supported by the presence of roads in new settlement areas.

Labor wage was defined as wage for off-farming works, and since off-farming wage can consist of various sectors, such as poultry, manufacturing, mining, services, and so forth, regional minimum wages (UMR) in 33 provinces in Indonesia for the period 2006–2013 were utilized. The data were calculated in hundred thousand to million Rupiahs and were sourced from the Ministry of the National Development Planning (Bappenas). Labor wage was expected to have a negative relationship with deforestation since better wage encourages people to work in the non-agricultural sectors. The negative relation between off-farm wage and forest clearing via agricultural expansion indicates that increasing return (wage) to off-farm employment would attract workers to work off-farm, thus reducing the agriculture productivity which eventually lead to lowering the pressure against forest [37].

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The cost of agricultural production was defined as the total accumulative cost farmers incurred in running their land production activities which consisted of costs for seed, pesticide, fertilizer, wage, and gasoline, as well as other costs per hectare of area in 33 provinces in Indonesia for the period 2006–2013. The data were calculated in thousand Rupiahs per hectare and derived from FAO [38]. The cost of agricultural production was expected to have a negative relation with deforestation. This was based on the results of a study by Angelsen [39] which indicates that higher prices of agricultural output added with better roads facilities and lower production cost in terms of labor constitute the three direct causes of deforestation.

Agricultural productivity was defined as the gross domestic product generated from the agricultural sector based on the constant price in 33 provinces in Indonesia for the period 2006–2013. The GDP data were obtained from the Center for Statistics Agency (BPS) and calculated in billions of Rupiahs and was expected to have a positive correlation with deforestation. This is because when there is a higher-income-generating activity conducted such as farming, then higher return from farming will induce higher productivity and thus development will expand in that area. A study by Ibrahim et al. [40] supports this, stating that deforestation can be triggered by not only direct causes, but also indirect causes, such as GDP.

Price of crops was defined as the price of an agriculture commodity, such as rice, corn, soybeans, and so forth, in 33 provinces in Indonesia for the period 2006–2013. The price of crops data was derived from the Center for Statistics Agency (BPS) and calculated in IDR/kg. Price of crops was expected to have a positive relationship with deforestation since an increase in price of crops will encourage farmers to expand their productivity and expand agricultural land through forest clearing [41].

Infrastructure budget was defined as the Government's spending on infrastructure in 33 provinces in Indonesia for the period of 2006–2013. The data of government spending on infrastructure were obtained from the World Bank [42] and calculated in trillions of Rupiahs. Government spending in the form of infrastructure project was expected to have positive correlation with forest conversion since if there is a huge amount of budget, there will be massive infrastructure development conducted and more forest being converted [43].

As in other studies, the main challenge for econometric methods is the effect of bias estimation. In this regard, this study also took into account controlling unobserved variables or omitted variables. These omitted variables comprised two major factors, namely government policies [29,44] and forest fire [45] which had an implication for forest land conversion. These unobserved variables were assumed to have a constant effect in each period of observation.

### *2.2 Methodology*

In order to investigate the impact of roads building on deforestation, this study applied the approach developed by Cropper, Griffiths, and Mani [36]. In their study, they introduce an equilibrium model which describes the economic intuition behind farmers' decisions in

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managing land through land clearing activities. Farmer behavior in gaining maximum profit from agriculture production set the demand along with prices crop prices, quality of land and roads accessibility. Meanwhile, woods price and forest location which determine cost for clearing land constitute the supply side. The function that describes the amounted forested land to be opened for farming was resulted from equilibrium determined by the intersection of demand and supply. Based on the model of equilibrium, the amount of cleared land was determined by the number of farming households (N), access of land to market (t), fertility of land (Q), price of crops (pA), wage of labor (w), capital rental cost (r), length of road (R), prices of logs (pL), and slope of land (s).

In this study, the model uses panel data analysis with fixed effect regression. The selection of this kind of model was based on the fact that the study related with the role of roads on deforestation face issues from potential endogeneity whereas it has the possibility of delivering biased result. In this case, there was a possibility that we might overestimate the impact of roads on deforestation at certain location whereas in fact the effect was attributed to topographical aspects such as soil fertility, climate and land which become driving magnet for on-site farming production [46].

Based on this model, the econometric model that will be employed in this study can be formulated as follows.

$$lnDEF_{it} = \beta_0 + \beta_1 lnLOR_{it} + \beta_2 lnWOL_{it} + \beta_3 lnPOC_{it} + \beta_4 lnAGDP_{it} + \beta_5 lnPOP_{it} + \beta_6 lnBOI_{it} + \beta_7 lnCAP_{it} + \mu_{it} \quad (1)$$

Where: subscripts i represent Indonesia’s province and t represent the time period from 2006-2013. $\beta 0$ is the constant intercept parameter estimation; $\beta 1$- $\beta 7$ represent the slope of parameters estimation; $\mu$i,t represents the error term; DEFi,t represent the deforestation rate in province i at year t; LORi,t is the length of road per km in province i at year t; WOLi,t is the amount of labor wage from off farm sector in province i at year t; POCi,t is the index of crop prices in province i at year t ; AGDPi,t is the GDP from the agricultural sector in province i at year t; POPi,t is the number of population for each square kilometer area (km2) in province i at year t; BOIi,t is the amount of infrastructure budget in province i at year t; and CAPi,t is the total amount of agricultural production cost in province i at year t.

This study also imposed year effect regression for controlling variables that are constant across entities but vary over time by including time fixed effects. This allows the bias elimination from un-observables that change over time but are constant over entities and it controls for factors that differ across entities but are constant over time. Since econometric model frequently faced bias estimation issues especially BLUE, then in order to tackle this issues, a multicollinearity, heteroscedasticity, and autocorrelation testing were also conducted.

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## 3. Result and discussion

### *3.1 Result*

The statistical summary of the variables used in this research is presented in Table 1. The summary explains the correlation between deforestation and the prominent drivers of deforestation, in this case the growth of roads.

**Table 1.** Summary statistics of variables.

| Variable | Mean | Standar Deviation | Min | Max | Observation |
|---|---|---|---|---|---|
| logdef | 7.239886 | 3.088515 | 2.302585 | 12.16 \| | 264 |
| loglor | 9.37221 | 2.018556 | 2.302585 | 18.49 | 264 |
| logwol | 13.67613 | 0.4991363 | 6.558198 | 14.30409 | 264 |
| logcap | 11.0265 | 4.77233 | 2.302585 | 25.22889 | 264 |
| logagdp | 17.81177 | 1.903158 | 9.35 | 20.82 | 264 |
| logpop | 14.47169 | 3.294345 | 0.63 | 17.61 | 264 |
| logboi | 21.0933 | 10.73794 | 2.302585 | 29.53 | 264 |
| logpoc | 10.29382 | 1.951613 | 2.302585 | 22.8024 | 264 |

Notes: logagdp = log value GDP from the agricultural sector; logboi = log value budget of infrastructure; logcap = log value cost of agricultural production; logdef = log value deforestation rate; loglor = log value length of road; logpoc = log value price of crops; logpop = log value population; and logwol = log value wage of labor.

To choose which are suitable in this panel data method, first of all this study conducted Chow test by setting two kind of hypotheses:
Ho: Pooled Least Square
H1: Fixed Effect

In order to reject or accept null hypothesis, the p value result was then used as the basis for deciding accept or reject the null hypothesis. The result of the Chow test as follow (Table 2):

**Table 2.** Chow test result.

| | | |
|---|---|---|
| F test that all u_i=0: | F test (32, 224) = 12.97 | Prob > F = 0.000 |

From the Chow test as can be seen above, the result of p value equal to 0.000 which is lower than 0.05. This means that the result reject the null hypothesis or the suitable model is fixed effect. After conducting Chow test, then followed Haustman test by setting two kind of hypotheses:
Ho: Random Effect
H1: Fixed Effect

In order to reject or accept null hypothesis, the p value result was then used as the basis for deciding accept or reject the null hypothesis. The result of Haustman test as follow (Table 3):

**Table 3.** Haustman test result.

| | | |
|---|---|---|
| Ho: difference in coefficients not systematic | chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 37.18 | Prob>chi2 = 0.0000 |

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From the Haustman test as can be seen above, the result of p value equal to 0.000 which is lower than 0.05. This means that the result reject the null hypothesis or the suitable model is Fixed effect. Since after conducting two kind of testing (Chow and Haustman) the result deliver the same result, then the best model in this study was Fixed Effect.

This study also imposed F Test and the result are given below:
H0 : There is no effect of independent variable against dependent variable
H1 : There is an effect of independent variable against dependent variable

**Table 4.** F test result.

| | | |
|---|---|---|
| Fixed-effects (within) regression | | Number of obs = 264 |
| Group variable: id | | Number of groups = 33 |
| R-sq: within = 0.1743 | | |
| between = 0.206 | | |
| overall = 0.055 | | |
| F(6,225) = 7.91 | corr(u_i, Xb) = -0.8251 | Prob > F = 0.0000 |

From the F test (see Table 4), the result depicted that p value is lower than alpha 0.05 or 5%. This indicated that we reject H0 or means that there is an effect of independent variable against dependent variable. To identify which independent variable have an effect toward dependent variable, this study conducted T Test and the result depicted below.

**Table 5.** T test result.

| Independent Variable | Coefficient | Standard Error | *P* Value |
|---|---|---|---|
| *loglor* | 0.1717509 | 0.076215 | 0.021** |
| *logwol* | 0.8189966 | 0.2817395 | 0.004*** |
| *logagdp* | -0.1858808 | 0.1186907 | 0.119 |
| *logpop* | 0.0838154 | 0.0727289 | 0.250 |
| *logboi* | 0.016231 | 0.0130124 | 0.214 |
| *logcap* | -0.0811314 | 0.1355648 | 0.550 |
| *logpoc* | 0.0305114 | 0.078344 | 0.697 |

Note: * P < 0.10; ** P < 0.05; and *** P < 0.01

From T Test (see Table 5), there are two variables which show a significant result in affecting the dependent variable. The wage of labor and length of roads are independent variables which relate statistically significant at 1% and 5% significant level. Regarding the main independent variable (length of roads), the result showed the growth of roads significantly had a positive correlations with the rate of deforestation in Indonesia.

### *3.2 Discussion*

The empirical result shows that the length of roads is statistically significant or in the other word growth of roads contribute to deforestation. The correlation between roads and deforestation is positive which means that an increasing level in roads growth for 1%, may

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increase loss in forest area up to 0.172%. The interpretation of this result might be supported by three reasons.

Firstly, since roads building were intended to open a new area, then the construction activities are frequently followed by a massive migration of workers, for example from urban to rural areas nearby forest. Gradually, the migration of workers will be followed by settlers, creating a new settlement, inducing human economic activities, and then being followed by intensive shifting cultivation through slash and burning activities. If this farming productions system provides some benefits, including profit, then it will gradually attract more people to come and more forest will be converted through shifting cultivation. This condition reflects that there is a trade-off between environmental damage in the form of deforestation and economic development, which is in line with the result of a study by Locklin and Haack [47]. In their study, Locklin and Haack found that in order to establish a new settlement, the government policy closely related to roads construction will induce deforestation. The benefits received from the development of roads such as improvement of livelihoods and economic development will be balanced by the negative impact such as degradation of forest areas. Thus, this trade-off gradually will become severe when forest area no longer exists since it being converted into another land use.

Secondly, the presence of roads mainly correlated with the reduction of transportation cost. Lower transportation cost has implications for the total cost of production since this will have an effect on other components of costs such as post-harvest cost and marketing. Since roads building has the capability in transforming new areas into more attractive land for farming production, this condition will become a motivation for farmers to increase forest clearing. Roads building plays an important role in reducing the cost of transportation related to the activities of forested land clearing for the farming system [48]. The lower transportation cost will affect the cost of transporting input and output of farming production. Better roads access provides incentives for farmers/loggers to increase their productivity since lower transportation cost reduces the total cost for production.

In addition to the results of a study by Weinhold and Reis [48], the location of agricultural land also intensifies the impact of roads building in lowering transportation cost. This thought was based on Von Thünen’s theory which states that the decision with regard to agriculture expansion for farmers driven by the distance between land location and market [49]. The distance length between market and farmland related to the cost of transportation, eventually affecting production cost and crops price. According to Von Thunen, land for agriculture and forest constitute the two models of potential land use. In each hectare of agriculture land, a farmer cultivates their land by using labor cost and capital cost and obtains the land productivity which yields crops. The farmer then delivers the crops to the nearby market with certain price while also spend the cost of transportation. It is obvious that the farther the land location from the market, the fewer profitability that farmers receive from their farming production. Thus, the location of agricultural land might also determine the farmers’ decision in conducting agricultural expansion [46].

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Thirdly, deforestation is frequently induced by the presence of unofficial roads building. This kind of roads network is usually built by the concessionaire or private plantation companies to smoothen the operational work of logging or plantation industry. Since this kind of roads was built without government supervision and budget, then it will grant access for people to do more forest exploitation such as illegal logging, encroachment, forest degradation and the higher risk of forest fire [50]. Moreover, Sigit [51] found that in many developing countries, roads infrastructure development is often associated with logging operations in forests (industrial logs), pipeline networks from oil and gas operations, plantation development, and mining. In addition, Alamgir et al [52] found that planned and on-going roads building or railway network near the forested area will have an impact on the buffer zone located 1 km from both sides of roads and decreases the landscape connectivity sharply (89 % to 55%). In the end, roads construction will accelerate farm expansion, illegal logging, encroachment, and poaching which eventually threaten the existence of endangered species such as Rhinoceros, Orangutan, and Elephant.

The development of roads construction shows that there is process of trade-off between the economic activities that soon expand to region development and the environmental damage. When there is road construction project or road rehabilitation, then user of the roads will get benefit from this condition. Several benefits that might arise include decreasing transportation costs and higher profit from farming production system since access that connected from agricultural land to market are well established. Moreover, unprofitable land for farming production due to isolated location nearby forested area now become attractive for farmers and thus will trigger the encroachment of forest area through land clearing activities. In addition, the construction of roads as highways nearby forested areas might have chance to trigger deforestation indirectly since it will create spontaneous creation of unpaved roads toward area that still cover with forest [46].

In general, large portion of deforestation cases was concentrated in the developing countries, including Indonesia. The expansion of road network in Indonesia will threats the forest area since as soon as the economic development expands, then more land are being converted to support this. In this case, higher speed development of economic activities facilitated by the well-established roads network has an opportunity cost in the form of loss in forest area. This condition reflects the existence of a vicious cycle between the economic activities development and environmental damage.

It is also important to note the relationship between labor wages and rate of deforestation. The coefficients of labor wages have a negative relationship with deforestation which means that an increasing level in off farm wage by 1% might reduce the loss in forest area up to 0.819%. The negative relation between off-farm wage and forest clearing via agricultural expansion indicates that increasing return (wage) to off-farm employment would attract workers to work off-farm such as in the industrial or manufacture sector. The decreasing number of labor in the agriculture sector then reducing the agriculture productivity which eventually lead to lowering the pressure against forest [37].

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## 4. Conclusion

Based on the discussion presented in the previous chapter, there are several conclusions can be drawn. Firstly, the growth of roads in Indonesia over an eight years period (2006–2013) was significantly contributes to the deforestation rate in Indonesia. The enormous growth of roads infrastructure in Indonesia for 8 years indirectly contributed toward the diminishing number of forest area.

Secondly, the growth of roads has a positive correlation with deforestation since roads for three kinds of reason. The first one is the development of roads facilitate a trade-off between environmental damage and economic development. More roads are being build, then more forest land will be vanished since emerging economic development will have side effect on environmental damage in this case forest area.

The second reason is roads facilitate the reduction of transportation cost. More roads being build, then it indulgent farmers, concessionaire, loggers or poachers to access and make exploitation of forest area since they have less transportation cost. Thus, more forest land area will be degraded and eventually vanished.

The third reason was the growth of roads sometimes followed by the un-official roads building that lead to forest clearing activities. This kind of road was dominantly developed by concessionaire or plantation owner in order to support the accessibility of their working area. New un-official roads building was developed I order to open new area which then attract new settlers come and start to develop economic activities and development. Thus forests are starting to be under pressure from any illegal activities such as illegal logging, encroachment etc.

Based on result of this study, it is found that the increasing number of roads construction will have an effect on diminishing number of forest area in Indonesia. This result is in line with several studies that have been conducted in another region especially in tropical countries. Therefore, in order to prevent any negative consequences triggered by the presence of roads, the government should formulate policies for roads construction near forest areas with extra caution. The policy that undertaken by the government should prevent the intrusion of road networks development into remote areas dominated by forest, targeting establishment of protected areas in the region with higher treats of forest destruction, and protecting the forest frontier from the drastic changes in demand for agricultural commodities due to price fluctuation. Although limiting forest access is the primary way to deter land clearing, vigilant monitoring and enforcement of land use restrictions are also important to mitigate deforestation activity.

Since roads construction projects frequently were conducted in the level of site or district and determine by the availability of budget, therefore it would be interesting to know whether there is correlation between roads construction project in district and its local infrastructure budget with the forest clearing activities. Considering that this study does not focus on issues related to district’s roads construction and infrastructure budget, therefore these kind of issues can be addressed by study.

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