

Analysis The Impact of Economic, Population, Agriculture, and Foreign Investment on Deforestation in Indonesia

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Abstract

This research aims to prove several factors, including GRDP per capita, population density, agricultural land, and foreign direct investment (FDI), which are believed to be the causes of deforestation in Indonesia through the analysis of employs panel data covering 32 provinces in Indonesia from 2011 to 2021. The research findings indicate that population density, agricultural land, and FDI have a positive influence on deforestation in Indonesia, while GRDP per capita exhibits a negative correlation. Behind the research findings affirming the factors contributing to deforestation in Indonesia, government policies also play the most significant role in controlling the deforestation trend in Indonesia, either exacerbating or ameliorating the state of forests.

Keywords Deforestation, GRDP per Capita, Population Density, Agriculture Land, Foreign Direct Investment

INTRODUCTION

Environmental degradation is one of the ten threats to humanity identified by the High-level Panel on Threats, Challenges, and Change created by the United Nations (PBB) in 2003. Research conducted by Atav et al. (2015) confirms the theory of the new environmental paradigm, where environmental degradation occurs as a result of the disruption of natural balance and environmental crises caused by human intervention in nature.

Degradation of forests has been globally recognized as a serious environmental, social, and economic issue (Vásquez-Grandón et al., 2018). Indonesia occupies the second tie as the country with the largest deforestation from 1990 to 2020, with a reduction in forest area of 26.41 million hectares reported by the Food and Agriculture Organization (FAO) in 2020, contributing to 13.94% of global deforestation (Pendrill et al., 2019). Deforestation in Indonesia is one of the largest on a global scale (Agusti et al., 2020).

Economic activities conducted without considering sustainability can lead to forest and land degradation (Isnaini & Agustina, 2021). Forest management practices that contradict environmental policies and illegal logging for economic motives can exacerbate deforestation in Indonesia (Surandoko, 2021; Wirmayanti et al., 2021).

The risk of forest damage can also increase with the rising population density supported by poor resource management practices in Indonesia (Didiharyono & Kasse, 2021b). A higher population density means more people engaging in tree felling, leading to the expansion of deforested areas and the loss of biodiversity (Lugazo & Mushy, 2021). The role of the agricultural sector as a source of livelihood and a pillar of development has made Indonesia known as an agrarian country (Andrie & Novianty, 2021). However, the increase in land clearing permits, including for agricultural activities as indicated in SOIFO (the state of Indonesia's forest) in 2018, has contributed to deforestation in Indonesia, accompanied by



a decline in forest quality, as reported by FAO in the global forest resource assessment in 2014 and 2015 (Adila et al., 2021).

The strong link between deforestation in tropical regions and increased FDI (Foreign Direct Investment) in the primary sector over the past two decades has occurred because the rising inflow of FDI is often associated with increased resource consumption (Piabuo et al., 2023b; Huang et al., 2022). This supports research conducted by Tarascina (2018), where the impact of foreign investment (FDI) on manufacturing is much smaller compared to the primary sector, especially agriculture, as a common cause of deforestation in Indonesia.

LITERATURE REVIEW

New Environmental Paradigm (NEP)

The New Ecological Paradigm (NEP) theory that developed by Dunlap and Van Liere (1978) posits that gradual environmental changes that pose risks to humanity result from human activities aimed at increasing comfort, life expectancy, and domination (Mosanya & Kwiatkowska, 2023). NEP believes in human dependence on the balance of nature and the existence of limits to economic growth (Derdowski et al., 2020).

Teori Transisi Hutan

Discovered by A. S. Mather in 1992, the forest transition theory is a concept that states that land-use changes are interconnected with socio-economic changes in specific contexts (Poudyal et al., 2023). In the forest transition theory, deforestation is divided into three stages, where the initial stage is characterized by minimal deforestation rates and high land cover. The second stage is marked by a significant reduction in forest cover due to increasing deforestation rates. The third stage of the transition of the forest will be marked by a steady, ever-growing cover of the forest (Peters et al., 2023).

TCL (Tree Loss Cover)

According to Global Forest Watch (GFW), tree cover loss (TCL) refers to changes from a forested state to a non-forested state, such as clear-cutting, the loss of the forest due to fires, storms, and specific disease outbreaks (Egorov et al., 2023). Global estimates of tree cover determined by GFW use tree cover density (TCD), which is the density of tree cover on a map with a standard TCD of > 30%. This means that any pixel with more than 30% canopy cover represents a forest (Rafanoharana et al., 2023).

Economic Growth

Economic growth refers to the improvement in economic conditions through a continuous process in a specific region or country over a certain period of time (Finanda & Gunarto, 2021). Economic growth is reflected in the Gross Domestic Product (GDP) at the national level and the Gross Regional Domestic Product (GRDP) at the district or city level (Neldawaty & Dani, 2022) ; (Arifin, 2009). Economic growth has the capacity to create jobs and increase foreign exchange reserves for a country. Unfortunately, economic growth can

also accelerate environmental damage due to the increasing pace of economic activities (Arif & Hardimanto, 2023).

Population Density

Population density refers to the measurement of the population in a specific area, assessing the level of pressure on natural resources and reflecting human activity levels in a particular region (Carnegie et al., 2022). High population density in an area can complicate efforts to improve the quality of life and lead to various social problems, including economic issues, security concerns, and the availability of land and resource problems that have significant impacts on the environment (Yunianto, 2021). This is happening because the increasing population according to Neo-Malthusian theory can have adverse effects on the environment and quality of life, exerting pressure on the environment and accelerating the depletion of natural resources (Gatarić et al., 2022).

Agricultural Land

Agricultural land is defined by the Organization for Economic Co-operation and Development (OECD) as land areas that are fertile, under permanent crops, or under permanent grassland. Agricultural land serves not only to provide goods and services related to its intended land use (such as food and timber production) but also unintentionally provides goods and services such as aesthetics, cultural heritage, and biodiversity conservation (Li et al., 2023). The increase in agricultural cropland can enhance domestic food production and maintain low food prices. Unfortunately, this can have adverse effects on the diversity of plant and animal species due to habitat disruption around the agricultural area that extends (Zabel et al., 2019).

FDI (Foreign Direct Investment)

Foreign Direct Investment (FDI) is a type of investment that occurs when a country offers opportunities for foreign nations to invest capital (Fernandez et al., 2020). Several factors can influence the level of FDI in a country namely the government's stability, the size of a country's market, labor wages, currency exchange rates, and the availability of natural resources (Mahbub et al., 2022). FDI creates competition among countries to attract foreign investors because of its benefits, especially for developing countries, which can increase job opportunities and enhance the recipient country's infrastructure development (Wijoyo & Cahyono, 2020). However, despite its advantages, research conducted by (Hawk) 2020 shows that FDI leads to environmental degradation, including deforestation, especially in developing countries, as many foreign investors are more interested in countries with lax policies regarding natural resource management.

METHOD

The scope of research

This study is a quantitative research type with a descriptive approach, utilizing data from 32 provinces in Indonesia spanning from 2011 to 2021. The dependent variable in this



research is TCL (Tree Cover Loss) as a proxy for deforestation, while PDRB per capita, population density, agricultural land, and FDI serve as independent variables. Data regarding TCL is obtained from Global Forest Watch, while data concerning agricultural land is a combination of paddy fields and plantations in Indonesia acquired from the Ministry of Agriculture. Data for PDRB per capita, population density, and FDI are obtained from Statistics Indonesia (BPS Indonesia).

Data analysis method

This research employs a panel data regression analysis method. Panel data is a combination of time series and cross-sectional data, encompassing various observations within one analytical unit over a specific period (Baltagi, 2021). In the selection among the common effect model (CEM), random effect model (REM), and fixed effect model (FEM) as the estimation approaches, Chow Test, Hausman Test, and Lagrange Multiplier Test are utilized.

Research Model

The formulation used in the specification of the research model analysis is as follows:

$$TCL_{it} = \beta_0 + \beta_1 PDRBK_{it} + \beta_2 KP_{it} + \beta_3 LPT_{it} + \beta_4 \ln FDI_{it} + \varepsilon$$

Where:

TCL = Tree Cover Loss (Ha)

i = Province

t = Year Period

β_0 = Constanta

$\beta_{1,2,3,4}$ = Regression Coefficients

PDRBK = Gross Regional Domestic Product Per Capita (Thousand Rp)

KP = Population Density (People/Km²)

LPT = Agriculture Land (Ha)

FDI = Foreign Direct Investment (Juta US)

ε = Residual (error term)

RESULT AND DISCUSSION

Model Selection Test

Results of Model Selection Test

Table 1. Chow Test Results

Effects Test	Statistic	d.f.	Prob.
Cross-section F	18.939117	(31,316)	0.0000
Cross-section Chi-square	369.636984	31	0.0000

Results of the Chow Test in the table above show a chi-square probability value of 0.0000, which is below the 5% alpha level. Therefore, the fixed effect model is a more appropriate model compared to the common effect model.

Table 2. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	17.362280	4	0.0016

Results of the Hausman Test in the table above show a chi-square probability value of 0.0000, which is below the 5% alpha level. Hence, the fixed effect model is a more suitable model compared to the random effect model. The Lagrange Multiplier Test is not needed in the model selection test because both the Chow Test and the Hausman Test indicate chi-square probabilities below 5%, confirming the selection of the fixed effect model (FEM) as the more appropriate model.

Panel Data Estimation Results

Table 3. Panel Data Equation Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	53001.70	34559.96	1.533616	0.1261
PDRBK	-1.751517	0.632520	-2.769111	0.0060
KP	61.10667	123.1089	0.496363	0.6200
LPT	0.047828	0.021369	2.238211	0.0259
FDI	10.57245	4.930278	2.144392	0.0328

Based on the estimation results of the FEM model, the regression equation's outcomes are as follows:

$$TCL_{it} = 53001.70 - 1,751517 PDRBK_{it} - 61.10667 KP_{it} + 0,047828 LPT_{it} + 10.57245 FDI_{it}$$

T-Statistic Test

Table 4. T-Statistic Results

Variable	t-Statistic	Prob.	Decision	Statement
PDRBK	-2.769111	0.0060	Reject H_0	Significant
KP	0.496363	0.6200	Accept H_0	Not Significant
LPT	2.238211	0.0259	Reject H_0	Significant
FDI	2.144392	0.0328	Reject H_0	Significant

Based on the t-statistic tests, the results show that the P-Value < Alpha, which is 0.0060 < 0.05 and the t-statistic value is -2.769111, indicating that GRDP per capita has a negative and significant impact on the increase of TCL in Indonesia.



The t-statistic test results for population density indicate that the P-Value > Alpha, which is $0.6200 > 0.05$ and the t-statistic value is 0.496363, indicating that population density has a positive but not significant influence on the increase of TCL in Indonesia.

The t-statistic test results for agricultural land show that the P-Value < Alpha, which is $0.0259 < 0.05$ and the t-statistic value is 2.238211, indicating that agricultural land has a positive and significant impact on the increase in TCL in Indonesia.

The t-statistic test results for FDI indicate that the P-Value < Alpha, which $0.0259 < 0.05$ and the t-statistic value is 2.238211, indicating that FDI has a positive and significant influence on the increase in TCL in Indonesia.

Uji F-Statistic

Tabel 5. F-Statistic Test Results

F-Statistic	Prob.	Statement
28.89131	0,000000	Reject H_0

The F-Statistic test results indicate a probability value (0,000000) lower than alpha (0.05 or 5%), concluding that all variables collectively have a significant impact on the increase in the proxy for deforestation which is TCL (Tree Cover Loss) in 32 provinces of Indonesia.

Coefficient of Determination Test

Based on the R-Squared (R^2) value from the panel data regression estimation results, a value of 0,761904 is obtained, confirming that, as a whole, the independent variables (PDRBK, LPP, LPT, FDI) can explain 76,19 percent of the information to predict the variation in the dependent variable, TCL. The remaining or 23,81 percent is explained by other variables outside the research model.

The Impact of GDRP Per Capita on Deforestation in Indonesia

Based on the estimation results, GDRP per capita shows a negative and significant impact on the increase of TCL (tree cover loss) in 32 provinces of Indonesia during the 2011 to 2021 period. These estimation results are supported by the research conducted by Siregar et al. (2023) that there are other factors besides the increase of GDRP per capita that supposed to strongly cause deforestation in Indonesia as the result of the utilization of forest resources. Furthermore, research conducted by Zefaya et al. (2023) also found that the impact of GRDP per capita is not strong enough to cause forest damage.

According to the results study by Febriyanti et al. (2022), the economic growth can reduce environmental damage through government efforts to improve environmental policies. Notably, Indonesia's agreement with the United Nations in the Reducing Emission from Deforestation and Forest Degradation (REDD+) program since 2013 has led to increased government efforts to preserve forests in Indonesia. Some of these efforts include the implementation of more environmentally friendly economic activities, starting with the

National Medium-Term Development Plan (RPJMN) for 2015-2019, as well as the introduction of various new environmental policies such as Presidential Regulation No.5 of 2019 regarding the Suspension and Evaluation of New Permits for Primary Natural Forests and Peatlands, Government Regulation No.46 of 2017 regarding Environmental Economic Instruments, President Regulation No.8 of 2018 regarding the Postponement and Evaluation of Oil Palm Plantation Licensing, and the Enhancement of Oil Palm Plantation Productivity.

Based on the data, the condition of Indonesia's forest is still in the the second phase of forest transition since deforestation in Indonesia will continue until the coming years. However, the decline in the number of losses of forest coverage occurred consecutive from 2017 to 2021 shows improvements in forest management in Indonesia. This decrease in deforestation in Indonesia shows that the application of human awareness will be important to preserve the environment as contained in the theory of NEP, according to the results study by (Sulphrey et al., 2023) taking place in Indonesia at the present time.

The Impact of Population Density on Deforestation in Indonesia

Estimation results regarding population density show that population density has a positive but not significant impact on the increase in TCL (Tree Cover Loss) in 32 provinces of Indonesia during the 2011 to 2021 period. According to the results study by Kustanto (2022), as population density increases, land outside forest areas decreases, while the demand for agricultural land and settlements becomes more pressing, resulting in the continued narrowing of forests in Indonesia. Despite being thought to affect, based on the data by BPS Indonesia, only 12 out of 32 provinces studied in this research had population density figures above the national average of 142 people/km² in 2021.

Population unevenness or population concentration, according to research by (Wardani & Arnellis, 2019), tends to be concentrated in major cities in Indonesia due to various factors, including infrastructure, environmental and housing factors, population self-sufficiency, and population birth factors. Therefore, it can be concluded that the impact of population density on deforestation is only felt by specific provinces that have major cities serving as centers of urbanization.

The Impact of Agriculture Land on Deforestation in Indonesia

The estimation results regarding agricultural land show that agricultural land has a positive and significant impact on the increase in TCL (Tree Cover Loss) in 32 provinces of Indonesia during the period from 2011 to 2021. The Central Bureau of Statistics (BPS) records that the agricultural sector had the second-highest contribution in Indonesia after the manufacturing industry, contributing approximately 13,28% or 2.25 quadrillion rupiah to Current Market Prices by Industry of Gross Domestic Product (GDP) in 2021. The subsector of plantation crops was the highest contributor within the agricultural sector, contributing 3.94% or 668 trillion to the National GDP in 2021.

The conversion of forests into agricultural land is the most common driver of deforestation in many tropical countries (Pendrill et al., 2022). Agriculture contributes to



global warming with its 8% contribution to greenhouse gas emissions in Indonesia, increases deforestation through the expansion of agricultural land, especially oil palm plantations, and degrades the soil through the use of chemical substances in agriculture (Husen et al., 2022).

The Impact of FDI on Deforestation in Indonesia

The estimation results regarding FDI show that FDI has a positive and significant impact on the increase in TCL (tree cover loss) in 32 provinces of Indonesia during the 2011 to 2021 period. Research conducted by Malins (2018) has proven that FDI has had a detrimental impact on deforestation since the New Order era, with the enactment of Law No. 1 of 1967 concerning Foreign Direct Investment in Indonesia, which paid less attention to natural resource conservation. The negative effects of this FDI policy continued with Law No. 9 of 2007 concerning Capital Investment, as it provided legal protection for foreign investors who obtained special privileges from the government for the utilization of forest resources (Sompa et al., 2022).

Resource wealth, competitiveness, and government regulations can determine a country's level of FDI (Sasana & Fathoni, 2019). However, the most significant influence that can attract FDI is through government regulations and legal certainty (Budiono & Purba, 2023).

CLOSING

Conclusion

Based on the research results, it can be concluded that:

1. GRDP per capita has a negative and significant impact on deforestation in Indonesia.
2. Population density has a positive but not significant impact on deforestation in Indonesia.
3. Agricultural land has a positive and significant impact on deforestation in Indonesia.
4. FDI has a positive and significant impact on deforestation in Indonesia.
5. GRDP per capita, population density, agricultural land, and FDI collectively influence deforestation in Indonesia.

Suggestions

Some suggestions that can be derived from the results of this research include:

1. The government needs to reassess various regulations related to forest utilization in Indonesia to improve policies that are considered to have loopholes and weaknesses in preserving forests.
2. The government should enhance supervision of both the prerequisites for conducting activities and the oversight of activities directly or indirectly related to land and forest resource management in Indonesia.
3. The government should pay attention to the thresholds for the exploitation of land and forest resources in Indonesia so that the country's forest wealth can be used for future generations.

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