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The urbanization pattern, economic growth, CO2 gas emissions and land transportation intensity

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Abstract

This research focuses on the effect of CO2 gas emissions, urbanization and economic growth on the transportation intensity in Indonesia. Econometric analysis with Vector Error Correction Model shows that there is a difference in results of the long-term assessment and short-term effects. Changes to CO2 gas emissions, urbanization and economic growth were responded to fluctuate. If the three variables increase by 1%, the transportation intensity will increase varies according to the type of variable, including CO2 gas emissions, urbanization, and economic growth. We conclude that CO2 gas emissions, urbanization and economic growth affect the transportation intensity in the positive direction.

Keywords: Transportation intensity, Urbanization, CO2 gas emissions, Economic growth, Econometric analysis.

El patrón de urbanización, el crecimiento económico, las emisiones de CO2 y la intensidad del transporte terrestre

Resumen

Esta investigación se enfoca en el efecto de las emisiones de gases de CO2, la urbanización y el crecimiento económico en la intensidad del transporte en Indonesia. El análisis econométrico con el modelo de corrección de errores vectoriales muestra que hay una diferencia en los resultados de la evaluación a largo plazo y los efectos a corto plazo. Los cambios en las emisiones de gases de CO2, la urbanización y el crecimiento económico fueron respondidos a fluctuaciones, tendiendo a ser positivo hacia la

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intensidad del transporte a largo plazo. Si las tres variables aumentan en un 1%, la intensidad del transporte aumentará según el tipo de variable, incluidas las emisiones de gases de CO2, la urbanización y el crecimiento económico. Llegamos a la conclusión de que las emisiones de gases de CO2, la urbanización y el crecimiento económico afectan la intensidad del transporte en la dirección positiva a largo plazo.

Palabras clave: Intensidad de transporte, Urbanización, Emisiones de gases de CO2, Crecimiento económico, Análisis econométrico.

1. INTRODUCTION

Economic growth is a very complex process between the main factors concerning economic and non-economic factors (BOLDEANU and CONSTANTINESCU, 2015). Influential factors such as the transportation sector play an important role. The transportation sector is related to a sectoral approach to economic growth and stability considering that every country seeks to achieve stability in the economic system. Relations between various systems determine the success of aspects of production, including in developing countries (KINGSLEY HAYNES, 2001).

The economic resources of various regions have commercial value and able to support people's lives yet have not been optimally distributed to develop as a market area. The logistics transportation network for economic corridors is the main node (RALAHALU and JINCA, 2013). Economic growth has traditionally been associated with the demand for road transport, which leads to a steady increase in social and environmental impacts (ALISES et al., 2014). Transportation act to expand the scope of the distribution of goods or services, supports the distribution of efficient industrial inputs, and allows the pattern of specialization of production activities, which can lead to "Economics of Scale and Agglomeration Economics" (MELO et al., 2017). The strong network externality of transportation infrastructure can result in a nonlinearity relationship between transportation infrastructure and economic growth (TAOTAO DENG, 2013).

The importance of the transportation sector is not only showed in developed countries. This aspect becomes a problem and a solution in developing countries as well, to progress the economic growth. The use of transportation in developing countries and Archipelago like Indonesia is a crucial part. The rapid production system caused the increase of transportation intensity. Increase in transportation usage occurs in all types of land transportation modes each year. This increase has an impact on the high use of land transportation, including the number of passengers and transportation of goods from various regions in Indonesia (CENTRAL STATISTICS AGENCY, 2017).

The increase of tranportation intensity is in line with the increase in other aspects, such as environmental and social aspects, so that adequate systematic policies are needed for long-term management in Indonesia. The intensity of transportation is related to CO_2 gas emissions and complex urbanization. Many countries experience faster growth in CO_2 gas emissions than gross domestic product in the country. (Finel and Tapio, 2012). Whereas, economic development, one of which is in terms of transportation, requires insightful or environmentally friendly development (TODARO, 2000). The transportation sector is considered to be the main source of vulnerable air pollution in developing countries because it sits 90% of total CO_2 emissions. The rate of increase in CO_2 gas emissions is quite significant over the territory of Indonesia since 1990, and since 2000 it has been dominated by developing countries (EDDY, H., TRISMIDIANTO and SAMIAJI, 2008).

Urbanization cannot be separated from the transportation intensity, because the pattern of relations from region to region requires a method. The level of urbanization that is too low and ignores the needs of the city can slow economic progress. But uncontrolled urbanization will lead to economic inequality and other environmental problems. The growth of registered vehicles in response to rapid urbanization has caused acute traffic congestion, one of them, which is in the capital city has an impact on transportation policies, including the establishment of adequate transportation routes and means (RUKMANA D, 2018).

Previous research in G20 countries revealed a fourth variable causal relationship in the context of short-term air transportation. Economic growth tends to blend into the path of its long-run equilibrium in response to changes in other variables (ARVIN, PRADHAN and NORMAN, 2015). Other research is about the impact of economic growth, industrial structure and urbanization on the intensity of carbon emissions in China. There is a long-term relationship between the intensity of carbon emissions and other factors (ZHANG et al, 2014). Research in India reveals the influence of transportation infrastructure on economic growth. There is a two-way relationship between transportation and economic growth. Appropriate transportation policies must be maintained to improve transportation infrastructure and thus sustainable economic growth will occur in India (PRADHAN, R.P., BAGCHI, 2013).

Previous research suggests the relationship of the four variables in various countries. One study focuses on air transportation, while this study takes place in developing countries and islands in Indonesia. This research focuses on the land transportation sector considering that this sector has the highest number of uses compared to other transportation. Policy making in terms of increasing transportation intensity needs to consider urbanization, CO_2 gas emissions and maintain economic growth if a causal relationship is found between the four variables. Therefore, this study aims to examine the effect of gas levels of CO_2 emissions, urbanization and economic growth on the intensity of transportation from 1987 to 2015 in Indonesia

2. METHODOLOGY

This research was using aquantitative approach with econometric analysis methods. Secondary time series data from 1987 to 2015 were obtained from agencies and publications from national institutions such as the Indonesian Central Bureau of Statistics and the World Bank.

The intensity of transportation is illustrated through the estimation of the number of land transportation passengers by estimating motorbikes (2 passengers), private cars (4 passengers), buses / large cars (50 passengers) and then trains with a total population. Urbanization is illustrated by the level of urban population, namely the urban population of the total population in Indonesia in the year by taking data from 1987 to 2015. Gas CO_2 emissions are calculated from land transportation in units per capita in tons per km. Economic growth is indicated by the rate of growth of per capita income, namely gross domestic product / real GDP. Data is presented as a percentage (%).

Hypothesis testing used the Granger Causality analysis model. The statistical analysis tool used to test the hypothesis is the analysis of VECM (Vector Error Correction Model) through the software "Eviews 7.0". Vector Error Correction Model (VECM) technique with data stationarity test steps with Augmented Dickey-Fuller (ADF), integration degree test, optimal lag determination, Granger Causality test, Cointegration test with Kao Residual Cointegration Test (Engle-Granger Based), VECM estimation. The long-term influence was tested through the Johansen cointegration test. The data obtained were then tested through the Impulse Response function and Variance Decomposition to predict contributions and influences.

The hypothesis of this study is that there is a strong corellation between the variable CO2 gas emissions, urbanization and economic growth on the intensity of transportation in Indonesia. An analytical model to examine the empirical relationship between the intensity of carbon dioxide transportation, urbanization, and economic growth according to the time series was used:

$$TRAN_t = A_0\, PGDP_t^{\beta 1} CO2E_t^{\beta 2} URBN_t^{\beta 3} e^{\varepsilon t} \tag{1}$$

The logarithmic transformation of equation (1) is:

$$In(TRAN_t) = \beta_0 + \beta_1 In\,(PGDP_t\,) + \beta_2\, In\,(CO2E_t\,) + \beta_3\, In\,(URBN_t\,) + \varepsilon_t \tag{2}$$

With variables including PGDP as gross domestic product per capita (economic growth), CO2Et as CO2 emission gas in period t, URBNt as urbanization and TRANt as transportation intensity defined as TRAN_P (passenger transportation). T indicates the period of time or periodization while β is the number of linear combinations of Xt elements which are only affected by the shock transistor [β0 = ln (A0)]. Equation (1) states TRAN as a function of another variable. However, TRAN is not always the dependent variable. The other three variables can change into the dependent variable, giving a variety of different equations (1) and (2) with different long-term elasticities.

3. RESULTS and DISCUSSION

The results of the study on transportation intensity, CO_2 gas emissions, economic growth and urbanization are described in general to explore changes throughout 1987 to 2015 in Indonesia. The data presented comes from the data of the World Bank and the processed Indonesian Central Bureau of Statistics (EAST JAVA PROVINCIAL STATISTICS AGENCY, 2016; WORLD BANK, 2016).

Changes in land transport passengers occur every year. The rapid increase occurred during 1987 to 2015, namely from 46.5% to 271.2% of the population in Indonesia. Although the increase dominated, but the decrease in the number of passengers occurred 2 times, namely in 1998 and in 2003. The decline occurred due to the political economy crisis in Indonesia which peaked in 1998 and ended in 1999 cause the impact of the world economy in 2003 weakened. The graph of the number of passengers through the army in Indonesia throughout 1987-2015 is presented in figure 1.

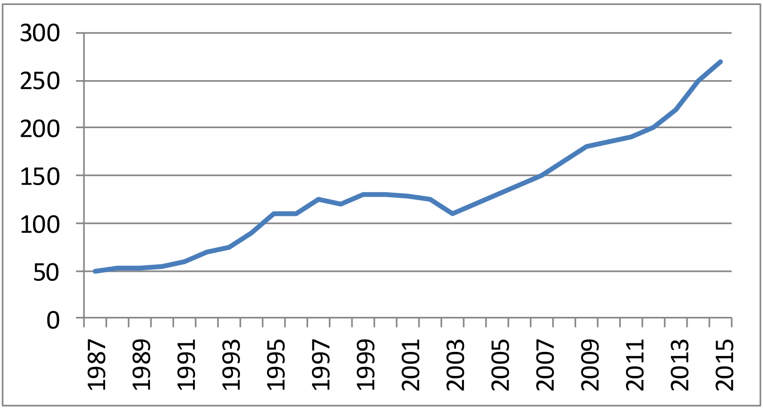

Figure 1: The number of passengers using land transportation in Indonesia from 1987-2015 (World Bank and Indonesian Central Bureau of Statistics)

The transportation sector contributes to the distribution of $CO2$ emissions, causing transportation sector to depend on oil and fuel. CO2 gas emissions in Indonesia in 2013 achieved 90%, this number was higher than in 1971. Significant growth began in 1977 and decreased by 24% in 1998. This decline also occurred due to the economic crisis. CO2 gas emissions that were generated from the transportation sector, from year to year, tend to increase. The graph of CO2 emissions in the land transportation sector in Indonesia in 1987-2015 can be seen in Figure 2.

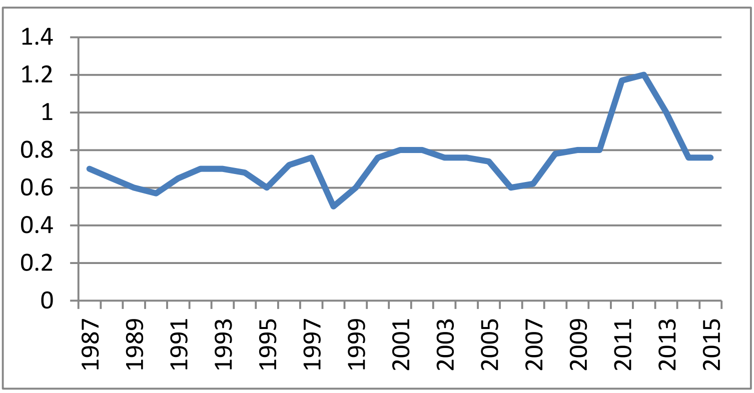

Figure 2: Graph of CO2 emission gas in the land transportation sector in Indonesia (World Bank and Indonesian Central Bureau of Statistics)

Indonesia's economic growth fluctuated from 1987 to 2015. Indonesia's economy began to improve after the 1998 crisis with economic growth that was not significant in 1999 at 0.79%. Economic growth figures indicate the existence of an economic recovery and continue until 2015 with an average growth of 5% -6%. The highest gross domestic product / GDP per capita was achieved in 2007 at 4.9% and then slowed down in 2008 to 4.6% and continued to slow to 3.2% in 2009. In 2009-2011 there began to be an increase, although in 2012 to 2015 there was a decline in economic growth. The graph of Indonesia's gross domestic product per capita in 1987-2015 can be seen in figure 3.

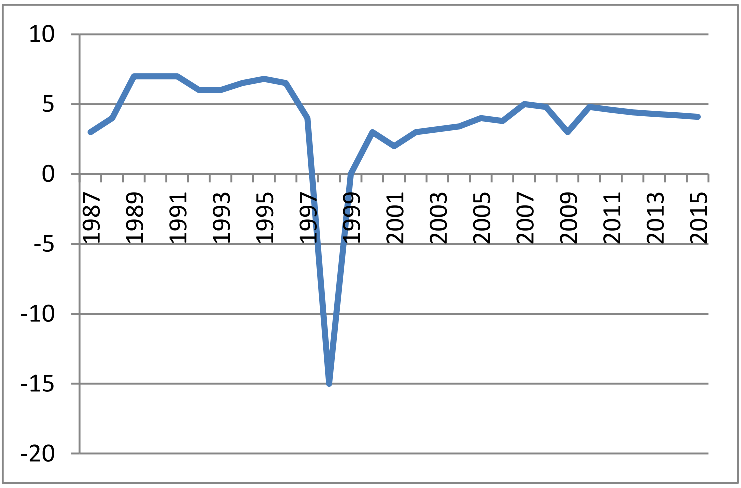

Figure 3: Graph of Indonesia's gross domestic product per capita (World Bank and Indonesian Central Bureau of Statistics)

In contrast to other fluctuating variables, urbanization showed a continuous increase from 1987 to 2015. Most cities in Indonesia grew an average of 4.1% per year and this marks a faster pace than other city in Asia region. In 2025, or less than 10 years before, it is estimated that 68% of Indonesia's population will be the urban citizen, viewed from the trend that has occurred to date. Between 2000 and 2010, urban population density in Indonesia rose rapidly, from 7,400 people per square kilometer to 9,400 people per square kilometer. Graphs of urbanization in Indonesia can be seen in figure 4.

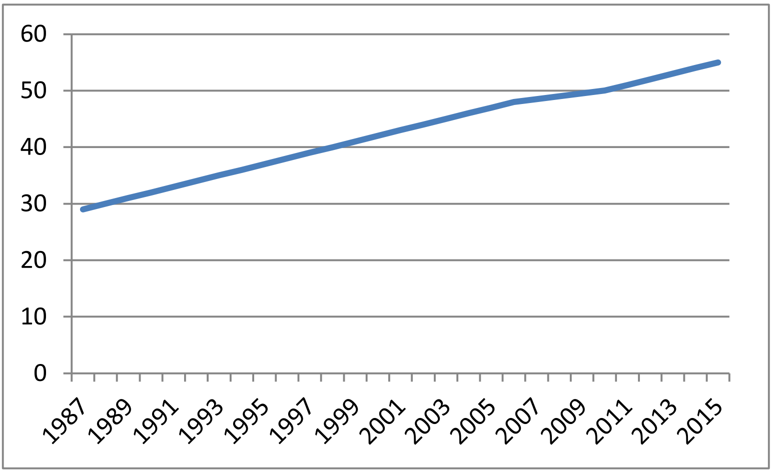

Figure 4: Graph of Indonesian urbanization (World Bank and Indonesian Central Bureau of Statistics)

Analysis of the Vector Error Correction Model (VECM) was analyzed in several steps. The first step is stationary test. The stationary test was tested in two stages, namely Augmented Dickey-Fuller (ADF) and Root Test Unit Level First Difference Augmented Dickey Fuller Test. Test results for Augmented Dickey-Fuller stationarity (ADF) in ADF Statistics recorded transport [-1.220279], Gas CO2 emissions [-1.478781], urbanization [-2.262888], economic growth [-0.853872] greater than MacKinnon Critical Value with a significance of 5% respectively [-2.986225, -2.971853, -2.976263, -2.971853]. Stationarity test results Root Test Unit Level First Difference Augmented Dickey Fuller Test on ADF Statistics recorded variable transportation [-3,299263], Gas CO2 emissions [-4,797855], urbanization [-4.910943], economic growth [-3.602943] greater than MacKinnon Critical Value with 5% significance in a row [-2.986225, -2.981038, -2.981038, -2.976263]. The stationarity test results from the two tests indicate that the data is stationary.

The determination of the optimal lag length test results, using the Selection Prediction Error (FPE) method, Aike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn (HQ). "Eviews 7.0", recommends optimal lags in lag 2 in processing data with LR [41.53054], FPE [9.59e-14], AIC [-18.72957], SC [-17.00179] and HQ [-18.21581].

The results of the Granger Causality test show that there are six (6) relationships in the model on 27 data. The gas CO2 emission variable seen from F-Statistic 2.15686 has a probability of 0.1395 towards the transportation variable. Conversely the transportation intensity variable seen from F-Statistic 3.87208 has a probability of 0.0362 to the variable CO2 emissions. The urbanization variable seen from F-Statistic 4.73865 has a probability of 0.0194 to the variable intensity of transportation. In contrast, the transportation intensity variable seen from F-Statistic 1.01029 has a probability of 0.3804 towards the variable of transportation intensity. The economic growth variable seen from the F-Statistic 5.55941 has a probability of 0.0111 to the variable intensity of transportation. In contrast, the transport intensity variable seen from F-Statistic 0.18583 has a probability of 0.8317 against the variable economic growth. The urbanization variable seen from F-Statistic 3.42430 has a probability of 0.0507 to the variable gas CO2 emissions. Conversely, the variable CO2 gas emissions seen from F-Statistic 138947 have a probability of 0.2702 against the variable urbanization. The economic growth variable seen from F-Statistic 3.17041 has a probability of 0.0617 to the variable gas CO2 emissions. Conversely, the CO2 gas emission variable seen from F-Statistic 0.41383 has a probability of 0.662 towards the variable of transportation intensity. The economic growth variable seen from F-Statistic 8.43216 has a probability of 0.0019 against the urbanization variable. Conversely, the urbanization variable seen from the F-Statistic 1.04554 has a probability of 0.3683 for the variable economic growth.

The Ganger Causality Test results state that the intensity of transportation and CO2 emissions have a relationship. The relationship between two variables was said to be an interdependence relationship. Transportation intensity is not related to CO2 emissions, but CO2 gas emission is related to the intensity of transportation. Likewise, urbanization is not related to the intensity of transportation while the intensity of transportation is related to urbanization. Economic growth is not related to transportation intensity and transportation intensity has a relationship with economic growth. Urbanization is not related to gas CO2 emissions and gas CO2 emissions have a relationship with urbanization. Economic growth is not related to CO2 gas emissions and also CO2 gas emissions related to economic growth. Economic growth is not related to urbanization and also urbanization is related to economic growth. This can be said because Ho is accepted at a significant level of 5%.

The cointegration test model is examined to determine the existence of long-term and short-term relationships. The test results show that the deterministic specification is the Quadratic Intercept trend. The results of the value cointegration test of Trace Statistic and Eigen Statistic with Johansen Cointegration state that there is a cointegration relationship on the model proposed at the 5% critical value with the model having a long-term relationship.

After going through these stages, the final results of VECM estimation in the long term for transportation intensity, the equation can be written as follows:

TRAN_Pt-1=- 31.48246 + 0.224618 CO2Et-1 + 2.393170 URBNt-1 + 4.357896 PGDPt-1,

In this equation, it can be seen that in the long run the level of CO2 emissions (CO2E), urbanization (URBN) and economic growth through gross domestic product (PGDP) has a significant effect on transportation intensity (TRAN_P).

Gas CO2 emissions, urbanization, economic growth, gas CO2 emissions in the long run significantly influence transportation intensity (TRAN_P). These results are obtained because with t-statistic values respectively amounting to [2.19781] [8.60100] [17.9095] which is greater than the t-table value of [2.045229642]. Each variable has a different influence. When the level of CO2 emissions increases by 1%, the transportation intensity will increase by 0.224618%. The urbanization rate has increased by 1%, the transportation intensity will increase by 2.393170%. When the economic growth rate increases by 1%, the transportation intensity will increase by 4.357896%. Whereas in the short term valuation, all variables in the short term are not significant. This can be seen by comparing the t-statistic value on the CO2 Emission Gas, Urbanization and Economic Growth variables which are smaller than the t-table value of [2.045229642].

4. CONCLUSION

We conclude that CO_2 gas emissions, urbanization and economic growth have a significant effect on the intensity of transportation in a positive direction. This research adds to the progress of the study literature and policy making regarding the intensity of transportation and its accompanying aspects in developing countries in the long run. Policy making in terms of increasing the intensity of transportation that does not simultaneously consider urbanization, CO_2 gas emissions and maintaining economic growth will present biased or misguided results for analysts and policy makers.

RESEARCH LIMITATION

This research is limited to one type of transportation and the tendency to refer to macroeconomic variables. Subsequent research has the opportunity to examine other aspects of transportation, considering that other transportation supports growth sector of a country, including sea transportation mode, given that Indonesia is a maritime country.

IMPLICATION

A direct policy implication of this result is economic growth that leads to increased transportation intensity through the provision of facilities, services and facilities and infrastructure in the transportation sector that prioritizes community satisfaction (consumers) in Indonesia and continues to prioritize effective and efficient and environmentally friendly aspects. Policy makers seek to put in place the policies that reduce air pollution, such as the development of high-speed large transportation systems as the main stream of passenger needs. The government can also encourage research and development of bio-fuel technology and target decarburization in urban transportation such as tightening vehicle standards in order to minimize CO2 emissions.

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