

EFFECTIVENESS OF TOLL ROAD AND RAILWAY INFRASTRUCTURE DEVELOPMENT IN INDONESIA

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Abstract

The purpose of this study is to analyze the effectiveness of toll roads and railways on welfare in Indonesia from the first quarter of 2006 to the fourth quarter of 2020. Toll roads are measured by the length of toll roads, railway lines are measured by the number of train passengers, and welfare is measured by GDP. per capita based on constant 2010 prices. Data analysis techniques use Vector Auto Regressive (VAR), Impulse Response Function (IRF), and Variance Decomposition (VD). The results show that toll roads are much more effective than railways in Indonesia during the study period.

Keywords: Toll Road, Railroad, Welfare

1. INTRODUCTION

Developing countries are spending a lot of money on transport infrastructure projects that will shape their cities for decades to come. Currently, about 20% of World Bank loans are used for transportation infrastructure, more than bank loans for social programs. In modern cities, road and rail investments are critical in land use planning and policy, feeder road and road network development, and utility spatial planning. Transport infrastructure generates direct welfare benefits through reducing travel and shipping costs, changing the shape of cities, and influencing the costs of the urban environment and the supply of land available for agricultural production (Baum-snow et al., 2017)

The success of a region's economic development can be seen from the output produced by the local community. In a regional context such as a province, the indicator of economic development to improve people's welfare is income per capita, which describes the average income received by each resident in a certain period of time. The greater the income per capita means the more successful economic development. On the other hand, a decrease in per capita income means a decrease in the level of community welfare. This means that per capita income can also be used as a benchmark for a region's economic growth. The economic growth of a country or region illustrates the success of economic development and is also believed to drip down to the bottom layer (trickle down effect) either by itself or because of government intervention (Amri, 2014).

The Indonesian state was formed not only to achieve independence, but the Indonesian state also has aspirations to create a just and prosperous society. But unfortunately the country's ideals are not all realized. The right time to realize general welfare is when Indonesia is now an inseparable part of globalization. the creation of prosperity for countries that are ready and able to take advantage of the opportunities that arise in the global era. If our nation is not competent, then what happens is that the Indonesian nation is crushed by globalization. The most obvious thing that causes poverty, environmental damage, the occurrence of extraordinary cultural erosion,

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disintegration, infectious diseases, and transnational organized crimes which can essentially be said to be the globalization of Crime (Prakoso et al., 2020). The way to realize these ideals is through development. One of the most important developments is the construction of transportation infrastructure.

Infrastructure is one of the factors that determine the economic growth of a country. Infrastructure is the driving force of economic growth. The supporting capacity of economic infrastructure is crucial in increasing production, smooth distribution process and increasing the effectiveness and efficiency of business operations. The low economic growth resulted in the government's financial capacity being very limited to be used to maintain, maintain and maintain the economic infrastructure. Infrastructure also has an important effect on improving the quality of life and human welfare, among others, in increasing consumption values, increasing labor productivity and access to employment, as well as increasing real prosperity and realizing macroeconomic stabilization, developing credit markets, and their impact on the labor market (Sephian & Adry, 2018). Regional economic development through the provision of road infrastructure is an important factor in efforts to improve the regional economy. Development in the transportation sector is aimed at supporting the development of provincial and city districts which are later expected to open isolation and encourage poverty alleviation (Amri, 2014).

Over time, humans always need something that can provide comfort and convenience that can be done efficiently and effectively to live their lives. In everyday life, humans really need infrastructure facilities and infrastructure to support their activities. In almost all parts of the world, in carrying out daily activities, a person needs a lot of supporting facilities and infrastructure so that his goals run well. This support is the availability of adequate infrastructure, where infrastructure has a very important role in the smooth driving of national development such as transportation, communication and information, energy and electricity, housing and buildings, water, roads. The availability of infrastructure plays a role in the distribution network, an energy source that can encourage increased productivity (Biomantara & Herdiansyah, 2019).

Having an important role in increasing the level of the economy is the transportation network infrastructure. One of the transportation network infrastructure is the Toll Road. Government Regulation No. 15 of 2005 explains that toll roads are public roads that are part of the road network system and as national roads whose use is required to pay tolls. Government Regulation No. 15 of 2005 explains that the construction of toll roads aims to improve the efficiency of distribution services in order to support economic growth, especially in areas that have a high level of Development (Barirotuttaqiyyah et al., 2020).

The development of road infrastructure in Indonesia plays an important role in facilitating the running of the economy for a region, especially toll roads, which are urgently needed to reduce congestion on main cross roads and can increase the distribution of goods and services, especially for areas that have begun to develop. The construction of toll roads has a very important role in supporting the pace of economic, social, cultural, community unity and integrity in interacting and functioning to connect between regions in Indonesia (Rahmayanti, 2020). Toll roads play an important role in connecting between regions in Indonesia (Ainiyah, 2020).

In addition to toll roads, transportation that can improve the regional economy is the railroad. The rail mode of transportation is still the mainstay of the community in general, considering the characteristics that rail transportation has is more effective and efficient when compared to other

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land transportation modes. However, trains have not yet become the dominant form of transportation for both passengers and goods in Indonesia (Kuswati et al., 2019).

Trains are cheap and affordable mass transportation and are environmentally friendly, but the existence of railway lines is not evenly distributed in Indonesia as well as toll roads. The toll road is a paid road so it is very opposite to the train. For this reason, this study examines which one is more effective between the construction of railway lines and toll roads in Indonesia.

2. LITERATURE STUDY

Research from (Septian & Adry, 2018) which examines the influence of infrastructure on economic growth in Indonesia. get results where road infrastructure has a positive and significant impact on economic growth in Indonesia. Research from (Amri, 2014) which examines the effect of transportation infrastructure and population density on per capita income in nine provinces in Sumatra. The results show that road infrastructure has a positive and significant effect on per capita income, while population density has no significant effect. Research from (R, 2020) which examines the impact of the Trans Sumatra Toll Road on the welfare of the community in Jatimulyo village, Kec. Jati Agung, Kab. South Lampung. The results show that although their work and income have not changed much. However, the compensation set by the government can be felt by residents of land affected by land acquisition.

Research from (Ainiyah, 2020) which examines the impact of the Gresik-Sidoarjo toll road construction on people's welfare in an Islamic economic perspective. The results show that with the road to, it increases farmers' income. Research from (Prakoso et al., 2020) which examines the impact of toll road construction on the social welfare of residents around the Madiun toll gate in 2020. The results show that with the existence of toll roads, residents can slowly improve social welfare in all aspects, starting from income, social security, education, health, tourism, and others. The social welfare conditions of the residents around the Madiun toll gate have now become fulfilled and the fulfillment of the needs of people's lives has increased more than before.

Research from (Ferrari, 2002) which examines the method of calculating tolls that determine the distribution of the cost burden between motorists and public financing so that social welfare can be optimized. The results show that the optimal toll roads do not depend on the fixed road segment fees that are imposed, whereas they are highly dependent on the marginal costs of public funds and the willingness of motorists to pay. If these two parameters are high, the optimal toll revenue collected on the highway may result in a higher cost than the actual road cost, so the resulting surplus toll revenue can be available for uses other than the road on which the toll is collected.

Research from (Kuswati et al., 2019) which examines the role of rail infrastructure in the regional economy in Indonesia. The results show that the variable number of traffic or service routes has a significant influence on GRDP growth in areas where there are rail transportation services. Research from (Biomantara & Herdiansyah, 2019) which examines the role of Indonesian railways (KAI) as transportation infrastructure for urban areas. The results show that rail transportation provides increased accessibility and connectivity between regions to support and develop the region. Research from (Okoye et al., 2019) which examines the heterogeneous impact of colonial railroads in Nigeria. The results show that Railways enhance economic development

in the short term, particularly in areas with low pre-railway access to export ports, including most of the North of the country. This effect persists to this day, although the railroads no longer function.

Research from (Jedwab & Storeygard, 2019) examining the economic and political factors in infrastructure investment: evidence from railways and roads in Africa 1960-2015. The results show a strong correlation between transport investment and economic development as well as more political factors including pre-colonial centralization, ethnic divisions, European settlement, natural resource dependence, and democracy. Research from (Kim & Go, 2017) examined the impact of railroads on the local economy in the United States. The results prove that railroads contribute to the growth of market-oriented agriculture in rural areas, and increased productivity in the local manufacturing sector. Research from (Fernando, 2014) which examines the impact of railroads on economic growth in the United States. The results show that railroads have a strong impact on the US economy.

Research from (Donaldson & Hornbeck, 2016) which examines the relationship between railroads and economic growth in the US. The result is that the value of farmland increases substantially as the railroad network in the United States increases. Research from (Hongchang et al., 2018) which examined the impact of high-speed rail (HSR) on economic activity in 200 Chinese cities used a new data set from 2007-2014. The results show that the benefits of HSR in terms of increasing China's GDP substantially outweigh the fixed costs, depreciation, and large HSR subsidies. Research from (Mccarthy & Zhai, 2019) which examines the economic impact of short rail infrastructure in Georgia. Finds that cumulatively, the six systems increase annual output in the \$2.8 - \$14.5 million range, increase annual revenues in the \$0.7 - \$4.1 million range, generate annual value added in the \$1.4 - \$7.5 million, and each year adds an average of 10–93 jobs.

Research from (Yi & Kim, 2018) which analyzes the spatial economic impact of road and rail accessibility levels on manufacturing output, with a focus on substitution and complementarity of intra and intermodal relationships. Finding that increasing rail accessibility increases the local manufacturing industry's marginal value added related to changes in road accessibility. The marginal value added with respect to rail line accessibility changes increases with rail line accessibility levels, resulting in an increase in returns to scale.

3. RESEARCH METHODOLOGY

This research is located in Indonesia, the data in this study starts from 2006-2019. The data was obtained from the Central Statistics Agency (BPS) in the form of welfare (WF) measured based on per capita income at constant prices in 2010 measured in percent, toll roads (TR) measured by track length (KM) and railway lines (RR) measured based on the length of the railroad track (KM).

The analytical method used in this research is Vector Autoregression (VAR). A policy is said to be effective, if the contribution of policy shocks to endogenous variables has the largest role (in percent) compared to other policies (Satrianto, 2017). The model of the effectiveness of fiscal and monetary policies on economic growth using the VAR model is shown as follows:

$$\begin{aligned}WF_t &= \alpha_{1i} + \sum_{i=1}^n \beta_{1i}WF + \sum_{i=1}^n \gamma_{it}TR_{t-i} + \sum_{i=1}^n \delta_{1i}RR_{t-i} + \varepsilon_{1t} \\TR_t &= \alpha_{1i} + \sum_{i=1}^n \beta_{1i}WF_{t-i} + \sum_{i=1}^n \gamma_{it}TR_{t-i} + \sum_{i=1}^n \delta_{1i}RR_{t-i} + \varepsilon_{2t} \\RR_t &= \alpha_{1i} + \sum_{i=1}^n \beta_{1i}WF_{t-i} + \sum_{i=1}^n \gamma_{it}TR_{t-i} + \sum_{i=1}^n \delta_{1i}RR_{t-i} + \varepsilon_{3t}\end{aligned}$$

4. RESULT AND DISCUSSION

Stationary Test

Table 1:
Stationary Test Results of Welfare, Toll Roads and Railroads

Variabele	Augmented Dickey- Fuller test statistic	Conclusion
Welfare (WF)	0.0000	Stationer
Toll Roads (TR)	0.0000	Stationer
Railroads (RR)	0.0000	Stationer

Source: Results of Data Processing Eviews 9

The first step taken to analyze the effectiveness of toll roads and railways on the balance of payments is the stationary test. From the stationary test, it turns out that the welfare variable, toll roads & railways are not stationary at the level and 1st difference because the probability value of each variable is greater than 0.05. Therefore, the stationary test was carried out at the 2nd difference stage. All variables are stationary at the 2nd difference because the probability value of each variable is smaller than 0.05. This condition is shown in table 1.

Optimal Lag Test

The next step is to perform an optimal lag test. Optimal lag selection is important because it can affect the acceptance and rejection of the null hypothesis, lead to estimation bias and can result in inaccurate predictions. The methods used to determine the optimal lag are Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwarz Information Criterion (SIC), and Hannan Quinn Information Criterion (HQ) with a minimum value. From table 2 it can be seen that the minimum values of all these criteria appear a lot in lag 4. Therefore, it can be said that the optimal lag in this model uses lag 4.

Table 2:
Optimal Lag Test Results of Toll Road and Railroad Effectiveness Models on Welfare

Source: Results of Data Processing Eviews 9

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1135.366605	NA	9.09E+14	42.95723	43.06876*	43.00012*
1	-1132.377998	5.526103	1.14E+15	43.18408	43.63018	43.35563
2	-1131.11471	2.192877	1.53E+15	43.47603	44.25671	43.77624
3	-1126.272641	7.856942	1.81E+15	43.63293	44.74819	44.0618
4	-1091.405798	52.62920*	6.94e+14*	42.65682*	44.10666	43.21436
5	-1089.491613	2.672635	9.32E+14	42.92421	44.70863	43.61041

Stability Test

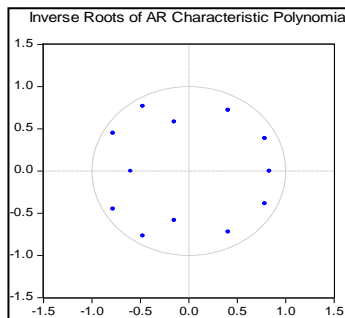


Figure 1: The AR Roots Modulus Value Model of the Effectiveness of Toll Roads and Railways on Welfare

After the optimal lag test, it is continued by conducting a VAR/VECM stability test. This test is carried out so that the IRF and FEVD results obtained are valid. The stability of the VAR/VECM system is seen from the inverse roots of the AR polynomial characteristics. If all the AR-roots values are inside the circle, then the VAR/VECM system can be said to be stable or vice versa. Figure 1 shows that all nominal AR modulus values are inside the circle. Thus, it can be said that the VAR system in this model is a stable VAR. A stable VAR will result in a valid or precise IRF and FEVD analysis.

Cointegration Test

Table 3: Cointegration Test of the Effectiveness of Toll Roads and Railways on Welfare

Hypothesized		Trace	0.05 Critical	
No. of CE(s)	Eigenvalue	Statistic	Value	Prob.**
None *	0.288929	34.62106	29.79707	0.0129
At most 1 *	0.249088	16.54895	15.49471	0.0346
At most 2	0.025449	1.366246	3.841466	0.2425

Source: Results of Data Processing Eviews 9

Next, the cointegration test is performed. This test is used to determine whether there will be a balance in the long term, that is, there is a similarity of movement and stability of the relationship between the variables in the study or not. If the model is cointegrated then the model is analyzed using the VECM method, but if the model is not cointegrated then the model is analyzed using VAR. Table 3 shows that the three hypotheses in this equation have a probability value greater than 0.05. Because the probability value for the three hypotheses in this equation is greater than 0.05, it can be stated that this equation is not cointegrated. Thus, the effectiveness of toll roads and railways on welfare can be estimated using a 2nd difference VAR model.

a. IRF Analysis

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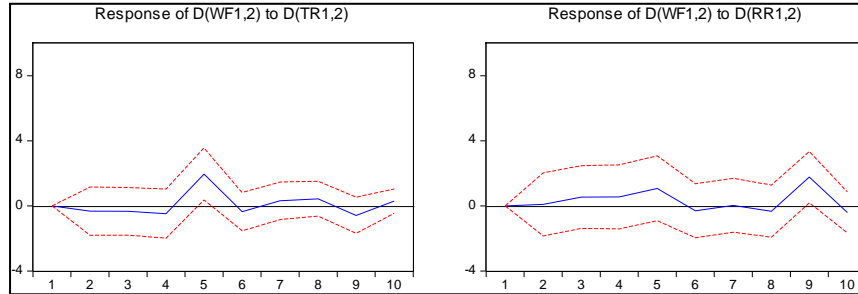


Figure 2: Welfare Response Due to Shock on Toll Roads (A) and Railways (B)

Then the Impulse Response Function (IRF) analysis is used to see the effect of shock from one variable on other variables. A shock to the endogenous variable will affect the variable itself and will spread to other endogenous variables. IRF provides the direction of the relationship between the magnitude of the effect of the endogenous variables. The estimation made for this IRF is focused on the response of a variable to a change in one standard deviation of the variable itself or of other variables contained in the VAR model.

Figure 2 (A) shows the response to changes in welfare as a result of the shock from the toll road. The existence of a shock from the toll road to the response to changes in welfare initially tends to reduce changes in output until period 4 but after that period, the output response moves closer to the equilibrium line and peaks in period 5. Therefore, the shock of the toll road to output will increase welfare, then decreased in the 6th period. This ups and downs continued until the 10th period. This means that the toll road shock is not permanent in the long term to welfare.

Almost the same condition is shown by the welfare response due to the shock of the railway line in Figure 2 (B). The shock of the railway line initially caused the welfare response to increase until the 5th period. Then it decreased until the 8th period. Until the 10th period, the welfare response was still moving up and down. In other words, the railway shock will not have a permanent impact on the balance of payments.

b. FEVD Analysis

To see and analyze the effectiveness of toll roads and railways on welfare, it is seen from the Forecast Error Variance Decomposition (FEVD) value. Table 4 shows that in general the variability of welfare in both the short and long term can be explained by the shock from the toll road (other than itself) of 0.2% in the short term and 7.23% in the long term. Meanwhile, the variability of welfare in the short term is explained by the railway line shock of 0.014 % and in the long term it is 7.41 %. This condition concludes that the most effective transportation for changing welfare in Indonesia is toll roads. This can be seen from the contribution of toll roads to welfare variability which is greatest compared to the contribution of the railway line.

**Table 4:
FEVD Test of Toll Road and Railroad Effectiveness Model on Welfare**

Variance Decomposition of D(WF1,2):				
Period	S.E.	D(WF1,2)	D(TR1,2)	D(RR1,2)
1	7.144377	100	0	0
2	7.15555	99.77642	0.209185	0.014399
3	7.339267	99.03804	0.41196	0.549997
4	7.531584	98.1476	0.801204	1.0512
5	8.052583	90.71022	6.591193	2.698585
6	8.071081	90.41404	6.759021	2.826941
7	8.117934	90.3778	6.826677	2.795522
8	8.149758	90.00162	7.05946	2.938922
9	8.396774	85.65478	7.137833	7.207389
10	8.413887	85.35889	7.230666	7.410445

Source: Results of Data Processing Eviews 9

Toll roads are more effective for welfare in Indonesia when compared to railroads because the effect of toll roads on welfare is so large. The construction of toll roads will affect regional development & economic improvement. Improve mobility and accessibility of people and goods. Toll road users will benefit from savings in vehicle operating costs (BOK) and time compared to using non-toll roads. Business Entities get a return on investment through toll revenues, which depend on the certainty of toll rates.

The railway line is considered less effective in this study, it does not mean that the railway line so far in Indonesia has not had an effect on improving welfare, but it means that the role of the railway line during the research period is less than that of the toll road. This condition is due to the fact that rail lines in Indonesia do not affect GDP per capita as much as toll roads. As we know, the active railway line is only centered in Java and parts of Sumatra, while the toll road exceeds the railway line, the Trans Java toll road, the Trans Sumatra toll road which is almost completed and has operated several segments, in Kalimantan it has also been operating. Samarinda-Balikpapan toll road, trans Sulawesi toll road, and Bali toll road.

From the results above, we can conclude that in social choice theory, every individual has a choice in improving their welfare, therefore, the priority in determining future development policies is the construction of toll roads, after that focus on other transportation such as railways.

5. CONCLUSION

The conclusion of this study shows that toll roads are more effective in improving welfare in Indonesia when compared to railroads. The effectiveness of toll roads compared to rail lines can be seen from the contribution of toll road shocks to welfare variability which is greater than that of railroads. Based on this conclusion, it is suggested to the government through the ministry of transportation to accelerate the construction of toll roads in order to accelerate the economy between regions, as well as to build railway lines, so that mass transportation mobility becomes smooth and reduces city congestion.

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