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MODELLING THE EFFECT OF INFRASTRUCTURE DEVELOPMENT ACCELERATION ON SUSTAINABLE ECONOMIC GROWTH IN INDONESIA

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ABSTRACT

Infrastructure development promotes economic growth. The government of Indonesia accelerates infrastructure development to increase its competitiveness. Lack of funding for infrastructure development in the Indonesian State Budget causes the government to seek other sources of funding, primarily debt. The object of this research is infrastructure investment and economic growth in Indonesia. The objective of this research is to develop a model for analyzing the effect of debt financing in infrastructure development, and then develop the proposed financing scheme to reduce the negative effects. This study is the first to use the engineering economy and portfolio management approach for projecting economic growth. The results show that higher investment in infrastructure development generates higher economic growth and private participation in infrastructure investment can reduce outstanding debt. Additionally, the importance of the project's economical rates of return must be considered in infrastructure investment decision making.

Keywords: Economic growth; Engineering economy; Infrastructure; Portfolio management

1. INTRODUCTION

Infrastructure development promotes economic growth (Cockburn et al., 2013; Kim, 1998; Pereira & Andras, 2013; Pradhan & Bagchi, 2013; The Centre for Spatial Economics, 2017; Wan & Zhang, 2018; World Bank, 2017). Lack of adequate infrastructure limits Indonesia's economic growth (Berawi, 2016; Cockburn et al., 2013; World Bank, 2017). According to the World Bank (2017), Indonesia has an infrastructure asset gap of USD 1.5 trillion. Since 2015, Government of Indonesia accelerates infrastructure development (Ministry of National Development Planning, 2014). Indonesia's infrastructure spending continuously increased from Rp154.7 trillion in 2014 to Rp410.7 trillion in 2018 (Ministry of Finance of Indonesia, 2018). This government ambitious infrastructure expansion plan has resulted in increasing foreign debt (Ministry of Finance, 2018).

Several studies predicted that in 2030 Indonesia's economy would be in top 5 global economies (Oberman, et al., 2012; Hawksworth et al., 2017; Gros & Alcidi, 2013). Unlike the previous studies, this is the first to project future economy of Indonesia using engineering economy and project portfolio approach.

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Theoretically, the effect from infrastructure to production output could be modeled in two ways: directly as a production factor and indirectly by influencing total factor productivity (Cockburn et al., 2013; Pradhan & Bagchi, 2013). An increase in infrastructure investment can reduce logistic and production cost, help promote agglomeration of economic activities, generate economies of scale and scope in production, promote improvements in human capital, and change aggregate demand (Pradhan & Bagchi, 2013; The Centre for Spatial Economics, 2017; Wan & Zhang, 2018; World Bank, 2017).

One of the best known economic growth models is the Solow growth model. The main assumptions in this model are the marginal product of both capital and labor are diminishing and constant returns to scale if capital and labor are linearly homogeneous (Acemoglu, 2008; Todaro & Smith, 2012). The aggregate production function used in the Solow growth model is:

$$Y(t) = AK(t)^{\alpha} L(t)^{1-\alpha}, 0 < \alpha < 1 \quad (1)$$

Where Y(t) is a gross domestic product, K(t) is the capital stock, L(t) is labor, and A (t) is total factor productivity. For formulating production per capita, we divide both sides of equation one by L (t), and then we have the production function per capita:

$$y(t) = Ak(t)^{\alpha} \quad (2)$$

Where y(t) is output per worker and k(t) is the capital-labor ratio. In conclusion, the Solow growth model emphasizes the importance of physical capital accumulation, which includes public capital, for economic growth (Todaro & Smith, 2012).

Engineering economy approach is used in this study because its formulas and techniques apply to all types of money matters, can evaluate economic factors, assist investment decisions, and estimate future expectation (Blank & Tarquin, 2012). Project portfolio management assures that the group of projects undertaken conform to the organization's objectives. Project portfolio management objective is to assist investment decisions to maximize value and minimize risk or uncertainty thus optimizing the organization's return on investment. Undefined or unclear returns on investments cause problems in many projects portfolios such as too many active projects, wrong projects committed, projects deviate from strategic goals, and unbalanced portfolios (Enoch, 2015; Kendall & Rollins, 2003).

2. METHODS

This study uses a spreadsheet program for developing cash flow and Monte Carlo simulation. Period used in the simulation is 16 years, from 2014 to 2030. Perspectives from the public, government, and investors are considered in the model development. All calculations in this study are inflation adjusted, using 2018 as a base year.

2.1. Basic Assumptions

Independent variables used in this study are the economic rate of return, interest expenses to debt ratio, GDP growth rate (excluding infrastructure development acceleration effect), tax to GDP ratio, and private investor expected rate of return. There are many approaches to estimating the economic rate of return or social discount rate (Zhuang et al., 2007). The median value for economical rates of return used in this study is 16%, based on research conducted by Herrera (2005) in East Asia and the Pacific region. GDP growth rate projections, excluding infrastructure development acceleration effect, for 2018 onward are generated from a continuous uniform distribution based on data from 2014 to 2017 (Ministry of Finance, 2018). Table 1 presents the independent variables used in this study.

Table 1 Independent research variables

Variables	Value	References
The economic rate of return	16%	Herrera (2005)
GDP growth	5%	Ministry of Finance (2018)
Investors' expected rate of return	8%	JPMorgan Chase & Co. (2015)
Interest expenses to debt ratio	5%	Ministry of Finance (2017)
Tax ratio	12%	Ministry of Finance (2018)

2.2. Model Development

In this study, typical individual project cash flows are assumed having initial investments distributed for five years, and then the established infrastructure generates annual benefits and revenues, as shown in figure 1. For generating project portfolio's cash flow, these individual project cash flows are simplified in resemblance of security investment cash flows, as shown in figure 2. Finally, the aggregate infrastructure investment cash flow model is created using a principle that every investment committed in a given year will start to generate values (benefits and revenues) six years after, as shown in figure 3. This aggregate infrastructure investment cash flow model is in resemblances of investment portfolio cash flow.

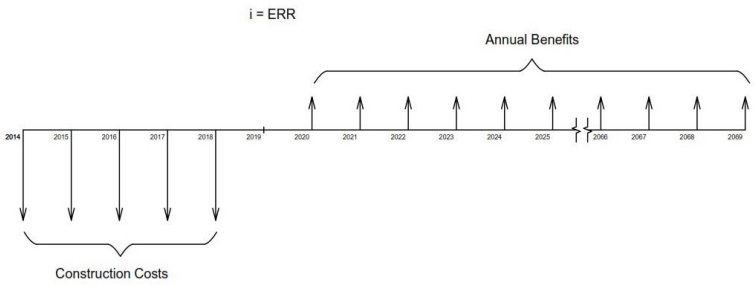

Figure 1 Typical individual infrastructure project's cash flow diagram

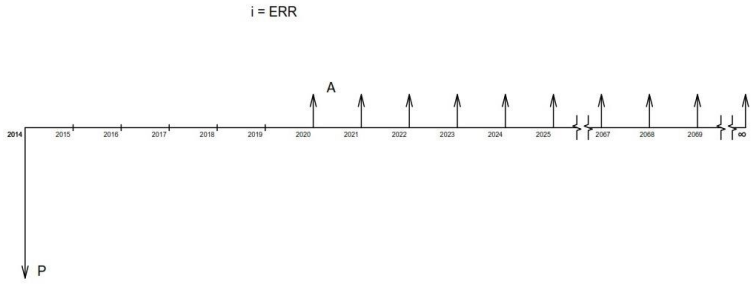

Figure 2 Simplified typical individual infrastructure project's cash flow diagram

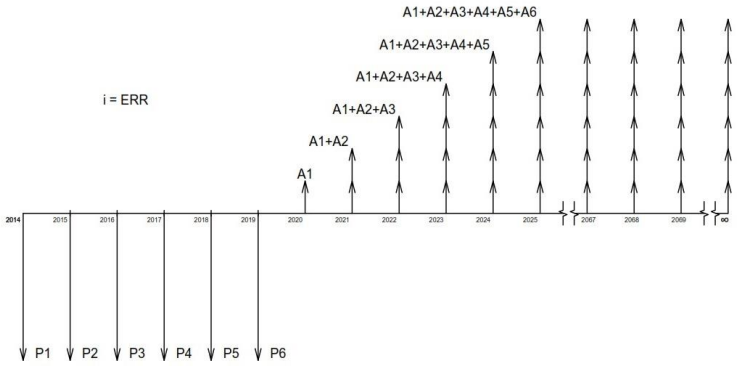

Figure 3 Investment portfolio cash flow diagram

Services provided by infrastructure are components of GDP. On the production side, the services provided by public infrastructure are considered as service produced in the country. On the consumption side, public gain benefits from both consumption and spillover effects of service provided by public infrastructure (Blank & Tarquin, 2012; Cockburn, 2013).

Public-private partnership investment in infrastructure has a complementary effect on private capital formation, not in substitution for it (Agenor & Dodson, 2006; Yescombe, 2007). On the other hand, overinvestment in infrastructure can crowd out private investment, either from increasing taxes or reducing the pool of funds available to private sectors (Shi, 2013). Considering Indonesia has underinvestment in infrastructure and infrastructure is financed either with debt or public-private partnership investment, crowding out effect in this study is assumed negligible.

Economic indicators used as outputs in the model are GDP, GDP growth rate, outstanding government debt, and outstanding government debt to GDP ratio. These economic indicators are estimated from 2018 to 2030.

2.3. Model Simulation and Sensitivity Analysis

In the model developed for this study, Monte Carlo method is used to simulate the economic rate of return, GDP growth rate, and interest expense to debt ratio. Three scenarios are simulated in this study, each using one thousand iterations. First scenario, total investments of USD 359.2 billion as planned in National Medium-Term Development Planning 2015-2019 can be achieved, and no additional large spending on infrastructure development committed. The second scenario, the government is investing additional USD 500 billion in infrastructure development from 2020 to 2024. In the third scenario, the government and private investors are investing additional USD 500 billion for infrastructure development from 2020 to 2024, with government share 65% and private share 35%. In addition, variables used in the sensitivity analysis are the economic rate of return, GDP growth rate, and interest expense to debt ratio.

3. RESULTS AND DISCUSSION

3.1. Economic Growth Estimation

Additional investment in scenario 2 and scenario three cause higher economic growth if compared with scenario 1, with an average growth rate of 7.07% from 2018 to 2030 and maximum GDP estimation of Rp 32,985.31 trillion in 2030. Table 2 and figure 4 show the GDP growth estimation results from this study. The coefficient of variation for GDP estimation is increasing rapidly with each passing year as shown in figure 5. This result shows that economic growth estimation in the distant future has low precision.

Table 2 Economic growth estimation results

Simulations	GDP in 2030 (trillion Rp)	Average Growth Rate from 2018 to 2030
Scenario 1	30,264.81	6.36%
Scenario 2	32,985.31	7.07%
Scenario 3	32,984.39	7.07%

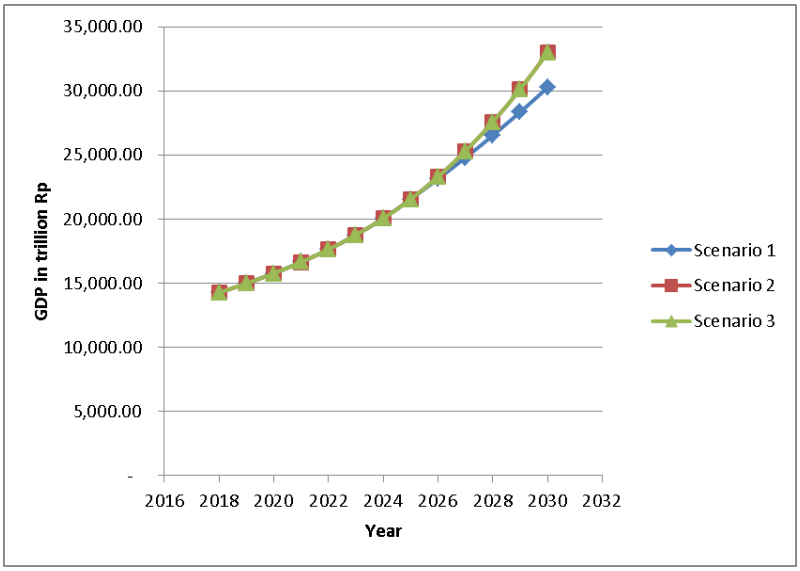

Figure 4 GDP estimation

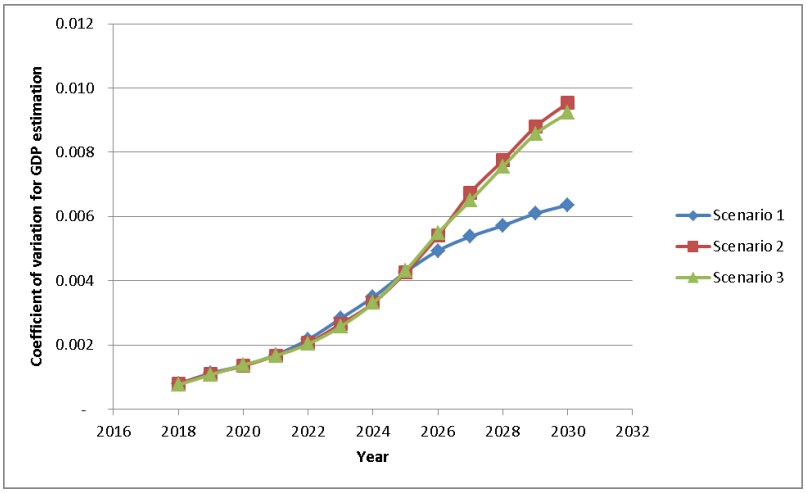

Figure 5 Coefficient of variation for GDP estimation

GDP growth rate estimation starts to increase in 2020 because of the delayed economic impact caused by infrastructure development. Start from 2025 the GDP growth rate estimation decelerates. This result shows that the effect of infrastructure investment on economic growth will diminish over time. Figure 6 shows the GDP growth rate estimation results from this study.

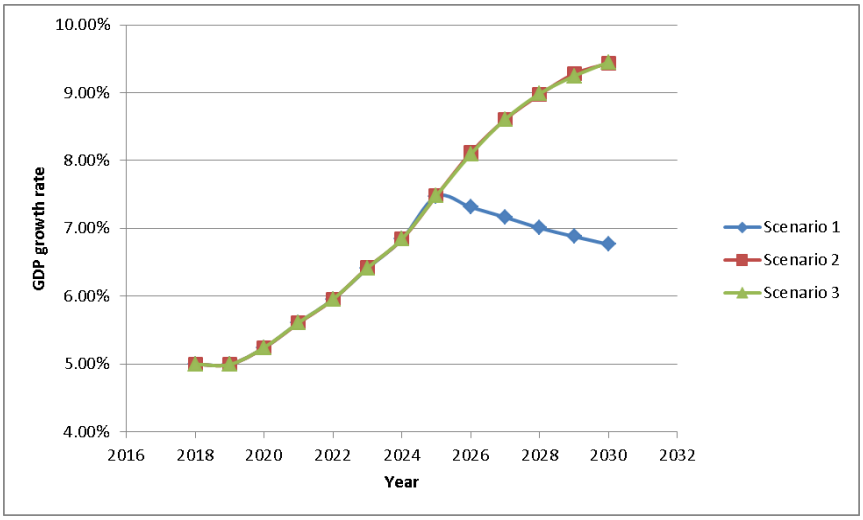

Figure 6 GDP growth rate estimation

3.2. Debt Estimation

Additional investment in scenario 2 and scenario 3 raises outstanding debt and debt to GDP ratio. The highest maximum debt to GDP ratio occurred in scenario 2, with a value of 49.38%, is still below the legal limit of 60% (Government of Indonesia, 2003). Results from scenario three simulation show that private participation in infrastructure investment can reduce outstanding debt and debt to GDP ratio. Although private investment has a relatively higher cost of capital than debt financing, it provides budgetary benefit and hence reduce the risk of the debt crisis (Yescombe, 2007; Todaro & Smith, 2012). Table 3 and figure 7 show the debt estimation results from this study.

Table 3 Debt estimation results

Simulations	Maximum Outstanding Debt (trillion Rp)	Average Outstanding Debt (trillion Rp)	Maximum Debt to GDP Ratio	Average Debt to GDP Ratio
Scenario 1	6,286.09	5,164.91	41.13%	27.21%
Scenario 2	9,903.19	7,818.60	49.38%	38.72%
Scenario 3	8,486.40	6,787.14	43.87%	34.28%

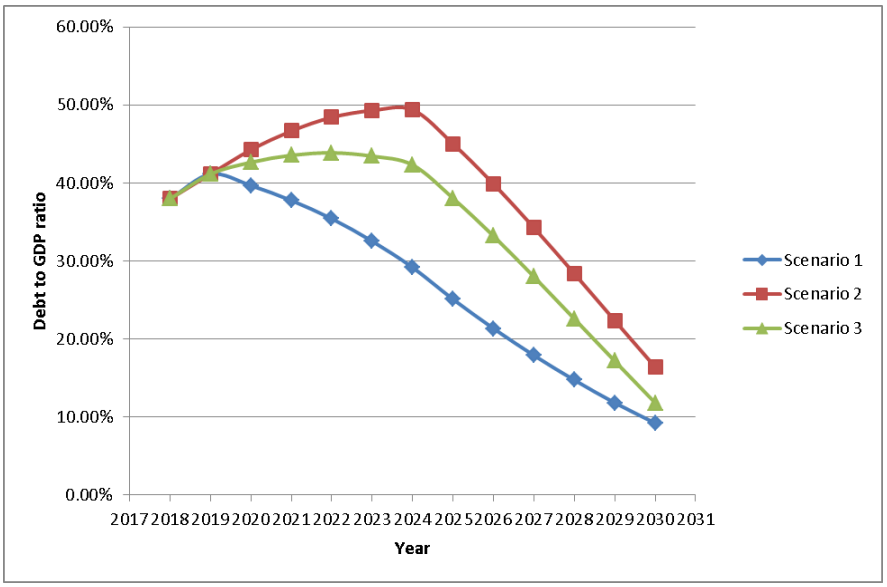

Figure 7 Debt to GDP ratio estimation

3.3. Sensitivity Analysis

From sensitivity analysis results, as shown in figure 8 and figure 9, variables that have a significant effect on economic growth and debt to GDP ratio are growth rate and economic rate of return. Considering that the growth rate is an external variable, the most important variable in infrastructure development that affects economic growth is the economic rate of return. Even though interest expense to outstanding debt and private participation in infrastructure investment do not affect economic growth, these variables affect maximum debt slightly less than the economic rate of return.

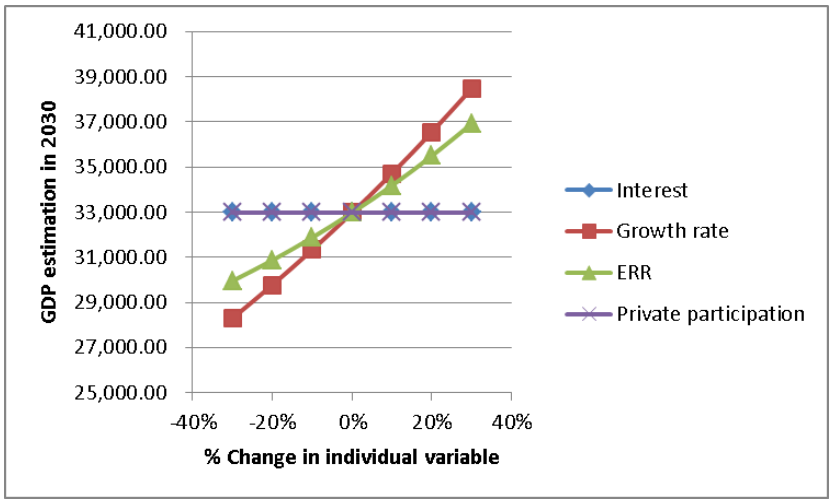

Figure 8 Economic rate of return influence on economic growth

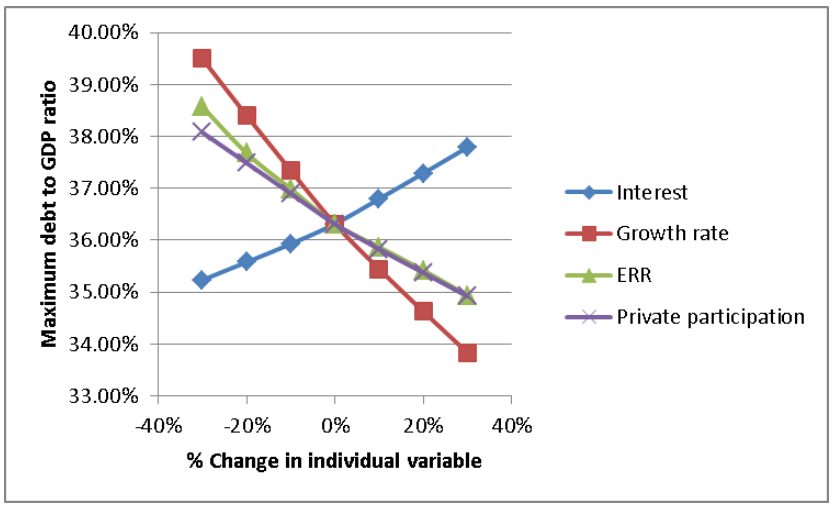

Figure 9 Economic rate of return influence to debt to GDP ratio

4. CONCLUSION

Infrastructure development acceleration has a positive effect on Indonesia's economic growth even though there is a negative effect in increased debt. The maximum GDP estimation in 2030 from this study is Rp 32,985.31 trillion, less than the estimation result from PricewaterhouseCoopers LLP of Rp 34,530.90 trillion or US$ 2,449 billion (Hawksworth et al., 2017). Due to its significance on economic growth, the economic rate of return should be emphasized in infrastructure development decision making.

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