Causality Relationship Between Infrastructure, Taxes and GRDP Per Capita in Aceh

Irham Iskandar
Research and development field
Aceh Province Regional Planning and Development Agency
Banda Aceh, Indonesian
irham.iskandar84@gmail.com

Sugiarto
Civil Engineering Department
Syiah Kuala University
Banda Aceh, Indonesian
sugiarto@unsyiah.ac.id

Wawan Hermawan
Department of Economics
Padjadjaran University
Bandung, Indonesian
w.hermawan@unpad.ac.id

Abstract

The main objective of this research is to see the causal relationship between infrastructure, taxes and GRDP per capita. The method used in this research is a quantitative approach with the variables are infrastructure, taxes and per capita GRDP. The infrastructure used here is the length of the road in kilometers; tax in rupiah units; while the GRDP used is per capita GRDP in rupiah units. All data used are secondary data in the form of time series data for the period 2006-2019. The results showed that first, infrastructure, taxes and per capita GRDP had no causality, but there was a one-way relationship, namely taxes affecting infrastructure; second, the cointegration test through the Johansen Co-Integration test shows that there is no cointegration; third, the function of impulse response and forecast error decomposition shows that the variable that most influences infrastructure and taxes is GRDP per capita, while the variable that most influences infrastructure is GRDP per capita; Fourth, the relationship variable based on the results of the Granger-Causality analysis test which is supported by the analysis of the impulse response function and the variance decomposition can conclude that the fluctuating tax growth has a direct effect (through per capita GRDP) on infrastructure improvement.

***Keywords**:* infrastructure, taxes and per capita GRDP

1. Introduction

Economic development is defined as a process that causes an increase in the real income per capita of the population of a country in the long run, accompanied by improvements to the institutional system. The rate of economic development is often measured by economic growth through the increase in Gross Domestic Product (GDP) or Gross National Product (GNI) produced by a country (Arsyad, 2010). Economic growth is a process of increasing per capita output for the long term, so that the percentage increase in total output should be higher than the percentage of the population and there is a long-term trend that this growth will continue (Tarigan, 2005). Process sentences are emphasized because they contain dynamic elements. The current theory of development economics continues to perfect the meaning and concept of economic growth. The theory states that economic growth is not only measured by the increase in GDP and GRDP, but also given immaterial weight, namely enjoyment, happiness, security, and peace felt by the wider community (Kuncoro, 2004). Economic growth determines the success of economic development. Income which is still relatively low and is supported by private consumption does not grow sustainably. According to Kuncoro (2004), this can be anticipated through investment, namely increased productivity which will have an impact on increasing economic growth, such as low-income Indonesia as a result of the gap between investment and savings as well as the foreign exchange gap which can be seen in the budget deficit. How is the condition of Aceh.

Figure 1 shows that the correlation between infrastructure and GRDP per capita is closely related. Infrastructure has fluctuated from 2001 to 2019 in line with the increase in per capita GRDP.

Roads are one of the most needed infrastructure for land transportation as a link between regions in supporting the national economy. The increase in economic mobility in 2002 through the national and provincial road networks, averaging 201 million vehicle-kilometers per day. This does not include economic mobility, which uses a district road network of 240 thousand kilometers and a village road network. This means that there are indications that the road infrastructure built so far has contributed significantly to the national economy (Kenastri, 2007).

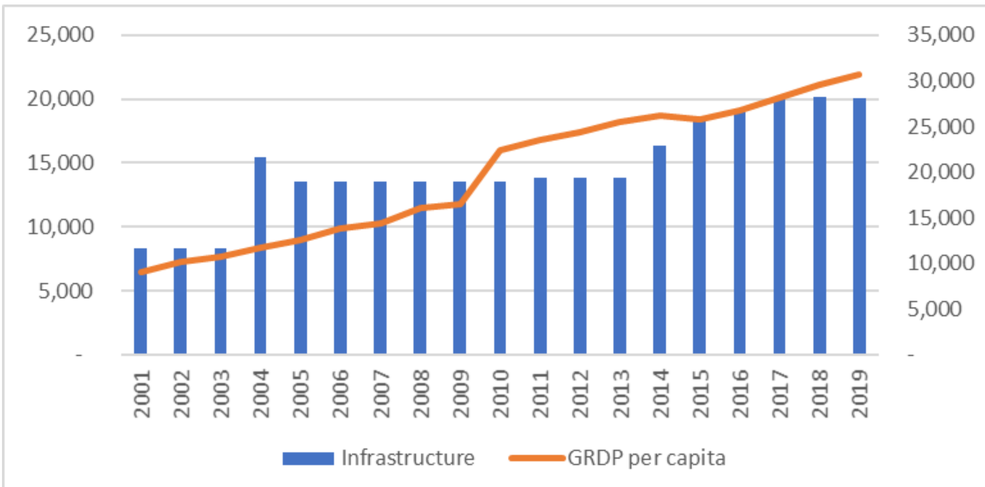

Figure 1. Correlation of Infrastructure and GRDP per capita

Economic growth is always supported by developments in each region such as infrastructure development. This is because infrastructure development is also an investment that can increase local income (taxes). The amount of road infrastructure investment issued by local governments has a strong influence on the development of economic growth. The term infrastructure in the large Indonesian dictionary means a public facility and infrastructure. Completeness of public facilities can be in the form of public facilities such as trains, hospitals, bridges, roads, sanitation, telephones, clean water, electricity, schools and so on; whereas in economics public infrastructure is a form of public capital from investments made by the government. Infrastructure related to roads, bridges, and sewer systems (Mankiw, 2003). The definition of infrastructure according to Larimer (1994) is a foundation that underlies basic services, facilities and institutions, but this depends on the growth and development of areas, communities and systems. In addition, infrastructure also explains the variety of services, institutions and facilities of the transportation system and public facilities, law and law enforcement, education and research. In line with this, Hirschman (1958) argues that infrastructure is something that is really needed, because without infrastructure all production activities in the economic activity sector (industry) cannot function. Economic theory identifies five channels through which infrastructure can have a positive impact on economic growth: (i) Infrastructure can be thought of as a direct input into the production process and hence serves as a factor of production; (ii) infrastructure can be thought of as a complement to other inputs into the production process, in the sense that improvements can lower production costs or shortages can result in total costs for firms, (iii) infrastructure can stimulate factor accumulation through, for example, the provision of human resource development facilities ; (iv) infrastructure investment can also increase aggregate demand an increase in spending during construction, and possibly during maintenance operations; and finally, (v) infrastructure investment can also serve as a tool to guide industrial policy; Governments may seek to activate this channel by investing in certain infrastructure projects with the aim of guiding private sector investment decisions (Fedderke & Garlick, 2008) The availability of infrastructure such as roads is a priority scale to achieve economic development. The provision of public facilities is of course faced with the funds needed. It is like in Indonesia where infrastructure funding is obtained from tax collection. The government should be able to provide public services such as the provision of quality roads, even though the provision of road infrastructure is very much needed, especially through tax collection. The government is expected to be a facilitator for the provision of good infrastructure so that it will have an impact on increasing economic growth. Related to the causality of taxes and infrastructure, there is still a lack of research, such as an empirical study in Indonesia.The results of empirical studies in the case of infrastructure causality and economic growth have been carried out by many countries, including Indonesia, namely Prasetyo & Sasana (2020) in ASEAN countries; Berk & Biçen (2018) in Turkey; Hidayah et.al (2018) in West Sumatra; Edrees (2016) in Arab; Simbolon (2018) in ASEAN countries; Tripathy et. al (2016) in India; Kumo (2012) in South Africa; Sebayang (2011) in Indonesia. Based on the description above, the purpose of this study is to determine the causal relationship between infrastructure, taxes and per capita GRDP. What is new in this study is that it complements the results of previous empirical studies, the latest data and the model developed, namely economic growth in a proxy as GRDP per capita. Furthermore, this paper is organized as follows. Section 1 contains an introduction covering the background and objectives of the literature. Section 2 describes the methodology used, Section 3 describes the data analysis, while Section 4 discusses the results of the analysis. Finally, Section 5 provides a conclusion.

2. Methodology

The method used in this research is a quantitative approach with the variables are infrastructure, taxes and per capita GRDP. The infrastructure used here is the length of the road in kilometers; tax in rupiah units; Meanwhile, the PDRB used is the per capita GRDP in rupiah units. All data used are secondary data in the form of time series data for the period 2006-2019. The method used is quantitative methods, namely using mathematical, statistical, and econometric models or other economic models to answer the research hypothesis. The estimation results are done using the cointegration test model and the granger causality test model or also known as the Engel-Granger method.

3. Results and Discussion

3.1 Stationarity Test

The stationarity test aims to determine whether the data has a unit root or not. The stationarity test in this study uses the Phillips-Perron (PP) test.

Table 1 at the Phillips-Perron level shows that the tax infrastructure and per capita GRDP variables are not stationary because the total probability is> 0.1 (10%), so it is necessary to continue with the first difference.

Table 1.Phillips-Perron Test Results

Method	Statistic	Prob.**
PP - Fisher Chi-square	1.14774	0.9794
PP - Choi Z-stat	1.86968	0.9692

Series	Prob.	Bandwidth	Obs
Infrastructure	0.6700	3.0	18
Tax	0.9376	1.0	18
Grdp_Per_Capita	0.8968	0.0	18

Source: Results of eviews, 2020

Table 2, The first difference, below finds that the variables for infrastructure, taxes and per capita GRDP have a probability of <0.1 (10%). This indicates that the three variables are stationary.

Table 2. Results of the Phillips-Perron test at first differences

Method	Statistic	Prob.**
PP - Fisher Chi-square	35.5081	0.0000
PP - Choi Z-stat	-4.80133	0.0000

Series	Prob.	Bandwidth	Obs
D(Infrastructure)	0.0010	2.0	17
D(Tax)	0.0076	1.0	17
D(Grdp_Per_Capita)	0.0026	1.0	17

Source: Results of eviews, 2020

3.2 Optimal Lag Length Test

The VAR approach is very sensitive to the amount of data lag used, therefore it is necessary to determine the optimal lag length. The determination of the length of the lag is used to determine the length of the period it affects an endogenous variable with the past time as well as on other endogenous variables. The determination of the lag length can be seen from the values of the Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC) and Schwarz Information (SC). The values can be seen from table 3 of the optimal lag length test results below.

Table 3. Optimum Lag Length Test Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-494.3688	NA	2.01e+23	62.17110	62.31596	62.17852
1	-456.3116	57.08579*	5.49e+21	58.53895	59.11839*	58.56863
2	-445.9586	11.64714	5.43e+21*	58.36983*	59.38385	58.42175*
3	-439.1140	5.133437	1.12e+22	58.63925	60.08786	58.71343

Source: Results of eviews, 2020

Table 3 shows that the lag value is in lag 2, where the lowest value for Final Prediction Error (FPE) is collected; Akaike Information Criterion (AIC); and Hannan-Quinn (HQ). Therefore, the optimum lag length is at lag 2.

3.3 Granger Causality Test

The Granger Causality test is used to see the causality relationship between the three variables studied, namely the causality between infrastructure, taxes, and per capita GRDP. Through this test, it can be seen whether all of these variables have a relationship that affects each other (two-way relationship), has a unidirectional relationship or not at all (does not influence each other). The results of the granger causality test can be seen in table 4 below.

Table 4. Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Prob.
Tax Does Not Granger Cause Infrastructure	17	3.56686	0.0609
Infrastructure Does Not Granger Cause Tax		1.69595	0.2246
Grdp Per Capita Does Not Granger Cause Infrastructure	17	1.52365	0.2572
Infrastructure Does Not Granger Cause Grdp Per Capita		0.53895	0.5968
Grdp Per Capita Does Not Granger Cause Tax	17	1.87217	0.1960
Tax Does Not Granger Cause Grdp Per Capita		0.08598	0.9182

Source: Results of eviews, 2020

Table 4, based on the results of the granger causality test above, it is known that among the causality of infrastructure, taxes and per capita GRDP, there is a one-way causality relationship, where taxes affect infrastructure. This can be seen at the probability value <0.1 (10%). These results indicate that there is an influencing relationship between taxes on infrastructure in Aceh. This is in line with research conducted by Sagita (2013) in Indonesia, and Kumo (2012) in Indonesia.

3.4 Cointegration Test

After it is known that the data on infrastructure, taxes, per capita GRDP are stationary, then we will then test whether there is a long-term balance relationship between infrastructure, taxes and per capita GRDP. This cointegration test aims to determine the long-term balance relationship between infrastructure, taxes and per capita GRDP by using the Johansen test.

Table 5. Cointegration Test Results with the Johansen Method

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.588191	24.67498	29.79707	0.1734
At most 1	0.418987	9.592654	15.49471	0.3134
At most 2	0.021067	0.361969	3.841465	0.5474

Source: Results of eviews, 2020

Table 5 above shows that there is no cointegration sign with the symbol (*) at most 1. If it is marked (**) or (*) at least one, then the equation must be solved by the VECM (Vector Error Correction Model) method.

Based on Johansen's cointegration test on the four variables in the system of equations, it can be seen the number of possible relationships, namely; First, the trace test identifies 1 cointegration equation at the 5%, 1% and 10% levels; Second, the max eigenvalue test identifies cointegration equations at the 5%, 1% and 10% levels. Thus, between the infrastructure variables, taxes and per capita GRDP, there is a relationship between long-term equilibrium stability and movement in the long term, while in the short term all variables adjust to each other to achieve long-term equilibrium.

3.5 Analysis of Impulse Response, Function and Variance Decomposition

3.5.1 Impulse Response Function

The impulse response function describes the prediction of the impact of the shock of a variable on other variables so that it can be seen how long the shock affects other variables, and selects the variable that gives the greatest response to the shock.

The vertical axis is the standard deviation value to measure how much response a variable gives, in case of shock to other variables, while the horizontal axis shows the length of the period of the response given to the shock. The response given above the horizontal axis indicates that shock has a positive effect. However, if the response is below the horizontal axis, it indicates that the shock will provide a graph of the impulse response function of each variable as a response.

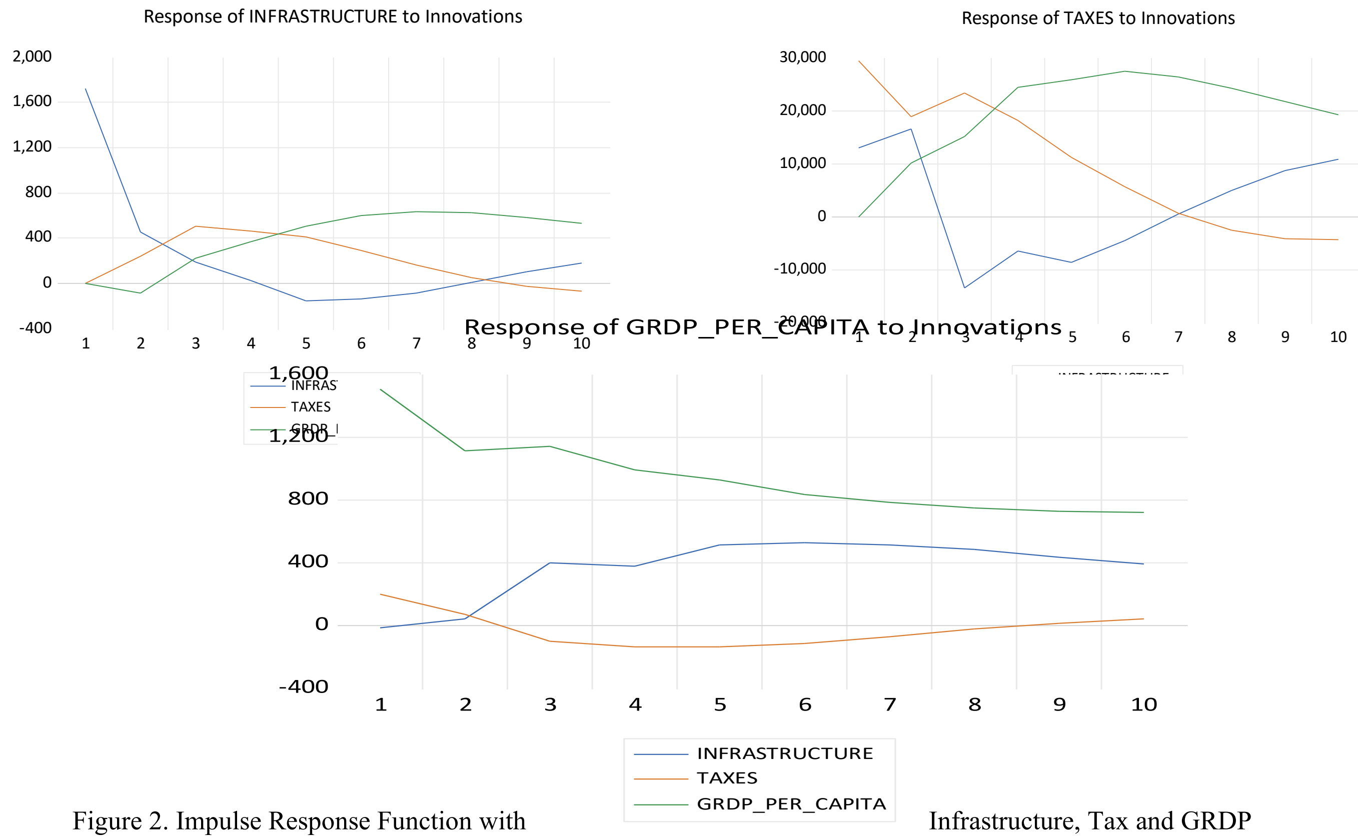

Figure 2. Impulse Response Function with Infrastructure, Tax and GRDP per capita

Figure 2, Analysis of the impulse response function with infrastructure as a response concludes that in the next 10 years, the highest response will be the response to the infrastructure itself, which is expected to stabilize at the tenth and ninth standard deviation. The next highest response is the infrastructure response to the per capita GRDP shock, which will stabilize at the tenth and ninth standard deviation. The response of infrastructure to taxes is close to zero standard deviation. Analysis of the impulse response function with tax as a response concludes that in the next 10 years, the highest response will be the response to the tax itself, which is expected to decline to near zero standard deviation. The next highest response is the tax response to the per capita GRDP shock and infrastructure, which will stabilize at the tenth and ninth standard deviation, respectively. Analysis of the impulse response function with per capita GRDP as a response concludes that in the next 10 years, the highest response will be the response to the per capita GRDP itself, which is expected to be stable at the tenth and ninth standard deviation. The next highest response is the per capita GRDP response to infrastructure and taxes, which will be stable at the tenth and ninth standard deviation, respectively.

3.5.2 Variance Decomposition

After analyzing the dynamic behavior of the model through the impulse response function, then the model characteristics will be seen through variance decomposition.

The results of the variance decomposition of the infrastructure variables in Table 6 show that the variable that is expected to have the greatest contribution to infrastructure in the next ten years is the infrastructure itself with an average annual contribution of 73.71 percent, followed by the per capita GRDP contribution. by 15.26 percent and tax by 11.01 percent.

Table 6. Variance decomposition of infrastructure variables

Variance Decomposition of Infrastructure:				
Period	S.E.	Infrastructure	Tax	Grdp_Per_Capita
1	1722.205	100.0000	0.000000	0.000000
2	1797.414	98.05891	1.726047	0.215039
3	1888.942	89.81237	8.582040	1.605592
4	1979.472	81.79599	13.24943	4.954576
5	2089.078	74.00126	15.66850	10.33024
6	2197.328	67.29919	15.88991	16.81090
7	2293.205	61.93870	15.07184	22.98945
8	2376.826	57.65729	14.07595	28.26676
9	2450.036	54.43497	13.26123	32.30381
10	2515.090	52.18352	12.66982	35.14666

Source: Results of eviews, 2020

Table 7 shows that the variable that is expected to have the greatest contribution to taxes in the next ten years is tax with an average contribution per year of 49.72 percent, which is contributed by the contribution of GRDP per capita of 34 , 11 percent and infrastructure 16.16 percent.

Table 7. Variance Decomposition of tax variables

Variance Decomposition of Tax:				
Period	S.E.	Infrastructure	Tax	Grdp_Per_Capita
1	32164.58	16.12916	83.87084	0.000000
2	41973.67	24.86017	69.27666	5.863167
3	52100.10	22.90411	64.81932	12.27657
4	60625.65	18.09111	56.74383	25.16506
5	67425.73	16.30605	48.64377	35.05018
6	73161.75	14.25191	41.92436	43.82374
7	77741.07	12.62648	37.13677	50.23676
8	81597.31	11.82262	33.81035	54.36702
9	84954.33	11.93570	31.43100	56.63330
10	87868.18	12.68895	29.62833	57.68272

Source: Results of eviews, 2020

Table 8 shows that the variable that is expected to have the greatest contribution to the GDP per capita in the next ten years is the GRDP per capita with an average contribution per year of 90.75 percent, which is followed by infrastructure contribution by 8.05 percent, and taxes by 1.19 percent.

Table 8. Variance Decomposition of the per capita GRDP variable

Variance Decomposition of Grdp_Per_Capita:

Period	S.E.	Infrastructure	Tax	Grdp_Per_Capita
1	1517.108	0.012347	1.619105	98.36855
2	1881.646	0.047264	1.170502	98.78223
3	2235.796	3.162115	1.048131	95.78975
4	2477.424	4.900198	1.159678	93.94012
5	2697.228	7.751373	1.252158	90.99647
6	2873.920	10.13003	1.274233	88.59574
7	3023.730	12.04383	1.208997	86.74718
8	3151.550	13.42303	1.120880	85.45609
9	3263.179	14.29684	1.046717	84.65645
10	3363.686	14.79094	0.998648	84.21041

Source: Results of eviews, 2020

4. Conclusion

Based on the results and discussion of the causality relationship of infrastructure, taxes and per capita GRDP, it can be proven that the three variables, namely infrastructure, taxes and per capita GRDP, do not have causality, but there is a one-way relationship, namely taxes affecting infrastructure. This suggests that the tax increase will improve infrastructure, including the addition of road infrastructure. The cointegration test through the Johansen Co-Integration test shows that there is no cointegration. The analysis of the impulse response function and the decomposition of forecast errors shows that the variable that most influences infrastructure and taxes is GRDP per capita, while the variable that most influences infrastructure is GRDP per capita. The relationship between variables based on the results of the Granger-Causality analysis test which is supported by the analysis of the impulse response function and variance decomposition can be relied upon that the fluctuating tax growth has an indirect effect (through per capita GRDP) on infrastructure improvement. The recommendations given are, first, to optimize the role of local government in infrastructure that can accommodate sufficiently, in this case the government acts firmly on tax collection so that taxes can become a resource for the government whose infrastructure is; second, it is necessary to supervise tax revenue and distribution so as not to misuse taxes; third, for further research it is necessary to examine the linkage between infrastructure and investment.

Reference

Arsyad, L. 2010. *Economic Development*. Yogyakarta: UPP STIM YKPN.

Berk, N., & Biçen, S. 2018. Causality between the Construction Sector and GDP Growth in Developing Countries: The Case of Turkey. *Athenian Journal of Mediterranean Studies*, Volume 4, Issue 1 - Pages 19-36.

Edrees, A 2016 Human Capital, Infrastructure and Economic Growth in Arab World: A Panel Granger Causality Analysis. *Eco J bus*, 7: 1.

Fedderke, J., & Garlick, R. 2008. *Infrastructure Development and Economic Growth in South Africa: A review of the accumulated evidence*. Policy Paper, Number 12; School of Economics.

Hidayah, F., Azhar, Z., & Putri, D. Z 2018. Causality Analysis of Economic Growth, Infrastructure and Tax Revenue in West Sumatra Province. *EcoGen*, Volume 1, Number 3.

Hirschman. 1958. *Economic Development Strategy*. New Haven: Yale University Press.

Kenastri. 2007. *Strategy Formulation for Financing and Large Scale Infrastructure Development*. Bogor: Bogor Agricultural University.

Kumo, W. L 2012 *Infrastructure Investment and Economic Growth in South Africa: Granger Causality Analysis. African Development Bank Group,* Working Paper No. 160.

Kuncoro, M. 2004. *Economic Development, Theory, Problems and Policy*. Yogyakarta: Erlangga.

Larimer, J. 1994. *Infrastructure*. In Int. Technology Res. Display Technology in Russia, Ukraine and Belarus, MD, USA .: Inst. Loyola University.

Mankiw, N. Gregory. 2003. *Macroeconomic Theory*, Fifth Edition, Publisher. Erlangga, Jakarta.

Prasetyo, D., & Sasana, H. 2020. Causality Analysis of Physical Infrastructure, Social Infrastructure and Economic Growth in Asean 2008-2017. *Diponegoro Economic Journal*, Volume 9, Number 4.

Sagita, R 2013 Causality Analysis of Infrastructure with Foreign Investment to Increase Indonesia's Gross Domestic Product (GDP). *EDAJ*, 2 (4).

Sebayang, L. K 2011. Analysis of the Linkage of Infrastructure Availability with Economic Growth in Indonesia: The Granger Causality Analysis Approach. *TRACE*, Volume 4, Number 1.

Simbolon., A. K 2018. Analysis of Cointegration and Causality Between Road Infrastructure, Trade in Goods and Economic Growth in Asean Member Countries,. QE

Tarigan, R. 2005. *Regional Economy*. Jakarta: Sinar Grafika Offset.

Tripathy, N., Srikanth, M., & Aravalath, L. M. 2016. Infrastructure Investment and Economic Growth: Evidence From India. *Journal of International Business and Economics*, 17 (1): 91-111 (21 pages).

Biography / Biographies

Dr. Irham Iskandar, SE, M. Si completed the SE in the field of Economic and Development Studies from Syiah Kuala University (Indonesia), M. Si in the field of Natural Resources and Environment from Syiah Kuala University (Indonesia), and Dr. in the field of Public Economics from Padjadjaran University (Indonesia). I now work in the field of research and development at Bappeda Aceh. Have special interests and experiences in the regional economy and the public economy.

Dr. Eng. Sugiarto holds B.Eng in Civil Engineering from Syiah Kuala University (Indonesia), M.Eng in Transportation Engineering from Asian Institute of Technology (Thailand) and Dr.Eng in Transportation Planning from Nagoya University (Japan). He now works as an associate professor at the Department of Civil Engineering, Syiah Kuala University. He has special interest and experience in transport planning, Policy, transport modeling, travel behavior analysis, transport psychology and sustainable transport.

Dr. Wawan Hermawan is a Senior lecturer and researcher at the Department of Economics, Padjadjaran University. He has been a researcher at CEDS since 1997. Dr. Hermawan earned his bachelor degree in Economics from Padjadjaran University, Indonesia (1997), a Masters degree in Techno Economics from Bandung Institute of Technology (ITB), Indonesia (2001) and PhD in Economics from Padjadjaran University, Indonesia (2013). Dr. Hermawan's research interest is in the area of Environmental Economics and his recent research topic is on The Impact of Climate Change on Agriculture and Its Implication on the Food Security in Indonesia: A Dynamic General Equilibrium Analysis.