PAPER – OPEN ACCESS

The Influence of Transportation Infrastructure and Population Density on GDP Per Capita in North Sumatra Province

Author : Naomi Amelia Siahaan and Arif Rahman
DOI : 10.32734/lwsa.v8i1.2386
Electronic ISSN : 2654-7066
Print ISSN : 2654-7058

Volume 8 Issue 2 – 2025 TALENTA Conference Series: Local Wisdom, Social, and Arts (LWSA)

LWSA Conference Series 08 (2025)
TALENTA Conference Series
Available online at https://talentaconfseries.usu.ac.id

The Influence of Transportation Infrastructure and Population Density on GDP Per Capita in North Sumatra Province

Naomi Amelia Siahaan, Arif Rahman

Program Studi Ekonomi Pembangunan, Fakultas Ekonomi dan Bisnis Universitas Sumatera Utara, Medan 20155, Indonesia

naomishn07@gmail.com

Abstract

The aim of this research is to determine the influence of transportation infrastructure and population density on GRDP per capita in districts/cities of North Sumatra Province in 2016-2022 The type of research used is quantitative using secondary data sourced from the Central Statistics Agency (BPS) with Cross Section 33 Regencies/Cities and the observation range is 2016-2022. The type of research used is quantitative research which is mathematical in nature and uses systematic formulas. The type of data in this research is secondary data using panel data regression method with Random Effect Model which ranges from 2016- 2022 and 33 Regencies/Cities of North Sumatra Province. The results of the research show that damaged roads have a significant negative influence on the GRDP of Regencies/Cities in North Sumatra Province. Meanwhile, good roads and population density have a significant positive effect on GRDP in the districts/cities of North Sumatra Province in 2016-2022

Keywords: Long Road In Bad Condition; Long Road In Good Condition; Population Density; GRDP Per Capita

1. Introduction

Transportation infrastructure is one of the determinants of GRDP (Aram, 2018). The development of adequate transportation infrastructure is believed to be determining factor in driving GRDP. History proves that there is not a region or country in the world that is lagging behind in the economic sector because Very adequate and high quality infrastructure development. Precisely with the limited and low-quality infrastructure conditions indicate otherwise (Susantono, 2013), so that the level of regional economic growth/GRDP is very high influenced by the development of adequate and increasing transportation infrastructure increases from year to year. GRDP growth will never develop quickly and progress, the development of transportation infrastructure is still very limited.

Availability transportation infrastructure in an area will cause a chain effect to other economic development. In short, chain effects are effects which is caused by the main cause, henceforth have further effects on improving the economy or social life in a region. Due to the chain effect arising from availability transportation infrastructure then various businesses or industries, both business industries Small and Medium Enterprises (SMEs) as well as large scale industries, will continue grow and improve rapidly. As a developing country, Indonesia still has many stages and processes faced in order to increase development in the economic sector, so that it is able to compete with developed countries. Improvement in the economic sector is the goal for the state so that people can prosper increases with increasing development.

2. Literature Review

2.1. GRDP

Gross Regional Domestic Product (GRDP) according to the Central Statistics Agency is the amount of gross added value produced by the internal business unit a domestic area. Or it is the sum of all the values of goods and services the final total produced by all economic activities in a region. “GRDP is an important indicator of economic growth in Indonesia a certain region and in a certain period (a year) produced by all economic activities in a country or region, there are two ways in presenting GRDP, namely on the basis of current prices and on the basis of prices constant” (Arifin, 2014).

Selection and peer-review under responsibility of Event of Young Researcher and Economics Students (EVEREST) VIII
p-ISSN: 2654-7058, e-ISSN: 2654-7066, DOI: 10.32734/lwsa.v8i1.2386

2.2. Transportation Infrastructure

Transportation comes from the word transportation, in English which is means transportation, which uses a tool to do work or it can also mean an activity of transporting and moving cargo (goods and people/people) from one place (place of origin) to another (destination). It can also be interpreted as a means of connecting or connecting connecting production areas and markets, or it could be said bringing production areas and markets closer, or often said to be a bridge producers with consumers. The role of transportation is very important, namely as a means of connecting, bring closer and bridge between parties who need each other (Adisasmita, 2012). Banerjee, et al, define that, infrastructure transportation is often cited as the key to driving growth and development. The argument relies on simple logic, that someone one needs to first have access to markets and ideas before one can benefit from it (Banerjee, et al. 2012). Transportation infrastructure is defined as any facility designed to transport people and goods, but not limited to sidewalks, footpaths, bicycle paths, roads highways, roads, bridges, tunnels, railways, mass transportation and parking systems. Clearly, defines "transportation infrastructure" as the basic structure which supports the delivery of inputs to production sites, goods and services to consumers, and consumers to the market. The structure is: transit, highway, airports, railways, waterways (ports), intermodal connections.

2.3. Population Density

Population density is an indicator of population pressure on an area. Density in an area is compared to the land area Occupancy is expressed as the number of inhabitants per square kilometer. When the quantity of population cannot be controlled, it will appear It's called population density. Population density is a measure of the population divided by area, because Population numbers change the measure of population increase or decrease population from the beginning to the population interval. More and more residents with a small area illustrates that in that area it has occurred which is called population density. There are several categories related to population density, including: gross population density, physiological population density, population density agrarian and economic population density. Population density is rough or frequent also called arithmetic population density shows the number the number of residents for each square kilometer of area. population density Physiological (Physiological Density) states the number of residents for each square kilometers of cultivated land. And density Agricultural population is a density that shows the number of people farmers for every square kilometer of cultivable land. Meanwhile density economic population (economic density of population) is a comparison between population with land area based on production capacity, explosion Rapid population has a negative impact on people's lives especially in the socio-economic field of society (Population Studies, 2015)

2.4. Economic Growth

According to Raharjo (2013), economic growth is an effort to increase production capacity to achieve additional output, which is measured using Gross Domestic Product (GDP) or using Gross Regional Domestic Product (GRDP) in a region. Simon Kuznets (in Arsyad, 2010) states that economic growth is a long-term increase in the capacity of the country concerned to provide various economic goods to its population. The increase in capacity is made possible by technological, institutional and ideological advances and adjustments to various existing conditions. Economic growth refers to an increase in production per person over a long period of time. There are three important things that need to be considered in economic growth, namely the process, output per capita, and a long period of time. This shows that economic growth focuses on the process, so it cannot be considered as a picture of economic conditions at a certain point in time. Some of the Classical Economic theorist such as Adam Smith explained how to analyze economic growth through two main factors, namely total output and population growth. In calculating total output, three variables are considered, namely natural resources, human resources, and capital. Meanwhile, population growth is used to determine the size of the market and the rate of economic growth. In the other hand, according to David Ricardo, to achieve economic growth, better technological development and adequate capital accumulation are required to increase labor productivity.

3. Research Method

This research uses a quantitative approach with panel data (pooled data) methods. It is said to be panel data because the data is a combination of Time Series and Cross Section. The time series data covers 2016 – 2022, while the cross section data covers individuals from 33 districts/cities. The data collection technique used is secondary data where data is obtained from BPS and then processed from other sources such as previous research, relevant journals and related articles to complete the information needed so far. study. The independent variable in this research is GDP per capita while the dependent variable in this research is roads in bad condition, roads in good condition, and population density.

According to Widarjono (2018) panel data regression has the same purpose as multiple linear regression, which predicts the intercept and slope values. The panel regression model is divided into 3 models, namely the Common Effect Model (CEM), Fixed Effect Model (FEM) and Random Effect Model (REM). Each model has a different type of formula, namely:

$$GRDPit = 0 + 1RBCit + 2RGCit - 3PDit + it \quad (1)$$

$$GRDPit = 0it + 1RBCit + 2RGCit - 3PDit + it \quad (2)$$

$$GRDPit = 0 + 1RBCit + 2RGCit - 3PDit + (i + it) \quad (3)$$

Description:
GRDP = Gross Regional Domestic Product
0 = Intercept
RBC = Road in Bad Condition
RGC = Road in Good Condition
PD = Population Density
1, 2, 3 = Slope
t = Year 2016 - 2022
i = 33 districts/cities
ε = Error Terms
= Disturbance Variable
*Each formula based on each model listed: Common Effect Model (1), Fixed Effect Model (2), Random Effect Model (3).

3.1. Model Selection Test

From the three models, it is necessary to select the best regression model by testing model specifications such as the Chow Test, Hausman Test, Lagrange Multiplier Test. The chow test is a test conducted to choose a good approach between the fixed effect model (FEM) and the common effect model (CEM). The Hausman test is a test used to choose whether the model used is the Fixed Effect Model (FEM) or the Random Effect Model (REM). The Lagrange multiplier test is a test used to choose the best approach between the Common Effect Model (CEM) and the Random Effect Model (REM). All of these tests are based on the following decision selection:

Tabel 1. Decision Making of Model Selection Test (*Source: Gujarati on Basic Economics)*

Model Selection Test	Condition	Decision
Chow	Prob cross section F > 0,05	CEM
	Prob cross section F < 0,05	FEM
Hausman	Prob Chi-Square > 0,05	REM
	Prob Chi-Square < 0,05	FEM
Lagrange Multiplier	Breusch-Pagan value > 0,05	CEM
	Breusch-Pagan value < 0,05	REM

3.2. Classical Assumption Test

After obtaining the best panel data regression model, it is necessary to test the classical assumption test so that the regression model is not biased and the research results are valid. This applies to regression models that use the OLS (Ordinary Least Square) method, namely CEM and FEM. However, the classic assumption test is not required for regression models that use the GLS (Generalized Least Square) method, namely REM. There are 2 classic assumption tests performed on panel data regression, namely multicollinearity and heteroscedasticity. Multicollinearity test is a method used to evaluate the significant relationship between independent variables in a multiple regression model. Multicollinearity test is usually performed when using more than one independent variable in linear regression, because if only one independent variable, multicollinearity is unlikely to occur. While the heteroscedasticity test is used to identify differences in residual variances between observations in the regression model. These tests are based on the following decision selection:

Table 2. *Decision Making of Classical Assumption Test (Source : Gujarati on Basic Economics)*

Classical Assumption Test	Condition	Decision
Multicollinearity	correlation coefficient value < 0.8	There is no multicollinearity problem
	correlation coefficient value > 0.8	There is multicollinearity problem
Heterokedasticity	prob value < 0.05	There is heterokedasticity problem
	prob value > 0.05	There is no heterokedasticity problem

3.3. Hypothesis Test

After that, hypothesis testing is carried out to see the answers to the research problems and the goodness of model. There are 3 hypothesis test, namely partial test (T-test), simultaneous test (F-test) and determination coefficient test (R2). The t-test is basically used to show whether the independent variable has an individual (partial) effect on the dependent variable. If its less than

0.05, the independent variable individually (partially) affects the dependent variable. And if its more than 0,05, the independent variable individually (partially) does not affects the dependent variable. The F test is used to see the significance of the influence of the independent variables (simultaneously) on the dependent variable. When the prob (F-statistic) is less than 0,05, then the independent variables simultaneously affect the dependent variable. But if its more than 0,05, then the independent variables simultaneously does not affect the dependent variable. Coefficient of determination is used to see how much the value / level of influence of the independent variables on the dependent variable. The test results are determined based on how large the value of the coefficient of determination (R2) is. A small R2 value means that the ability of the independent variables to explain the dependent variation is very limited. A value close to one means that the independent variables provide almost all the information needed to predict variations in the dependent variable.

4. Results and Discussion

4.1. Model Selection Test

To determine which regression model is chosen between fixed effect or common effect in this study, the Chow Test is required. The following are the results of the Chow Test:

Table 3. Chow Test

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	43.294768	(32,194)	0.0000
Cross-section Chi-square	482.301439	32	0.0000

Based on Table 3, the results of the Chow test show a cross-section F probability value of 0.0000. This value is smaller than the signification of 0.05 (0.0000 < 0.05), It means the chosen model for this test is the Fixed Effect Model (FEM). After this, the Hausman test is carried out to see which model is the best between fixed effect or random effect.

Table 4. Hausman Test

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	1.796233	3	0.6158

The results of the Hausman test on Table 4 show a random cross-section probability value of 0.615. This value is greater than the value of 0.05 (0.615 > 0.05), It means the chosen model for this test is the Random Effect Model (REM). The Last test used is Lagrange Multiplier test to see which model is best between random effect or common effect.

4.2. Classical Assumption Test

According to the Basic Econometric book written by Gujarati (2004), the GLS approach is able to produce a constant error variable value after being transformed. The result of the transformation produces an equation that is best linear unbiased estimation (BLUE), which fulfills the classical assumption test. In short, GLS is OLS with transformed variables that meet multiple linear standards. Therefore, classical assumption testing for the Random Effect Model (REM) does not need to be done because it uses the Generalized Least Squared (GLS) approach which already meets the best linear unbiased estimation (BLUE) properties.

4.3. Hypothesis Test

- Partial Significance Test (t-statistic test)

Based on the t-test results obtained from Table 5, it can be described through the following formula based on random effect model:

Table 5. Partial Test Result

Variable	Coefficient	Sig.	Description
Road in Bad Condition (RBC)	-0,021656	0,0942	Significant

Road in Good Condition (RGC)	0,119240	0,0001	Significant
Population Density (PD)	0,115751	0,0044	Significant

Source: Researcher Processed Data

$$GRDPit = 0 + 1RBCit + 2RGCit - 3PDit + (i + it)$$

$$GRDPit = 16{,}26338 - 0{,}021656\ RBDit + 0{,}119240\ RGCit + 0{,}115751\ PDit + [CX = R]$$

- Simultaneous Significance Test (f-statistic test)

Table 6. Simultaneous Significance Test Result

F	Sig.	Description
9,844436	0,000004	Significant

Source: Researcher Processed Data

- Coefficient of Determination (R2)

Table 4.6 Coefficient of Determination Result

Adjusted R2	Description
0,103835	Independent variables in explaining dependent variable are limited

Source: Researcher Processed Data

5. Conclusions

1. Based on the results of the discussion in the previous chapter, the following conclusions can be drawn: 1 Roads in bad condition have a positive and significant effect on the GRDP per capita of the districts/cities of North Sumatra Province in 2016 - 2022.
2. Good condition roads have a positive and significant effect on the GRDP per capita of the districts/cities of North Sumatra Province in 2016 - 2022.
3. Population density has a positive and significant effect on the GRDP per capita of the districts/cities of North Sumatra Province in 2016 - 2022.
4. Roads in bad condition, roads in good condition and population density simultaneously influence GRDP per capita in districts/cities of North Sumatra Province in 2016-2022.

References

[1] Adisasmita, S. A. (2012). Perencanaan Infrastruktur Transportasi Wilayah. Graha Ilmu. Yogyakarta
[2] Gujarati, D., (2004). "Basic Econometrics", Edisi 4, The McGraw-Hill Companies, New York
[3] Kartiasih, F. (2019). "Dampak infrastruktur Transportasi Terhadap Pertumbuhan Ekonomi Di Indonesia menggunakan regresi Data Panel". *Jurnal Ilmiah*
[4] Palilu, A., & Suripatty, R. (2018). "Pengaruh Infrastruktur Transportasi Terhadap Pertumbuhan Ekonomi Kota Sorong Provinsi Papua Barat". Ekuivalensi: Jurnal Ekonomi Bisnis, 239-257.
[5] Prishardoyo, B. (2008). Analisis Tingkat Pertumbuhan Ekonomi Dan Potensi Ekonomi Terhadap Produk Domestik Regional Bruto (Pdrb) Kabupaten Pati Tahun 2000- 2005.
[6] Rapika Kesatriani Damanik, S. A. (2020). "Pengaruh Jumlah Penduduk Dan Pdrb Terhadap Kemiskinan Di Provinsi Sumatera Utara". Jurnal Darma Agung
[7] Sukirno Sadono. 1983. *Ekonomi Pembangunan.* Jakarta: LP Universitas Indonesia.
[8] Sukirno, Sadono., (1997). "Pengantar Teori Makroekonomi", *Raja Grafindo Persada*, Jakarta.
[9] Widarjono, Agus. 2009. *Ekonometrika Pengantar dan Aplikasinya, Edisi Ketiga*.Yogyakarta: Ekonesia.
[10] Yunianto, Dwi. "Analisis Pertumbuhan Dan Kepadatan Penduduk Terhadap Pertumbuhan Ekonomi." *Forum Ekonomi*. Vol. 23. No. 4. 2021