UNIVERSITAS INDONESIA

THE SPATIAL SPILLOVER EFFECTS OF ROAD INFRASTRUCTURE ON REGIONAL ECONOMIC GROWTH IN THE WEST JAVA PROVINCE, INDONESIA

THESIS

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FACULTY OF ECONOMICS AND BUSINESS
GRADUATE PROGRAM
DEPOK
JUNE 2015

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Submitted as a part of the requirement for the Degree of Master of Science in Economics

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STATEMENT OF ORIGINALITY

I hereby declare that the intellectual content of this thesis is the product of my own work. I also declare that referencing have been made correctly to the best of my knowledge and any contribution made to the research by others is explicitly acknowledged in the thesis.

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ACKNOWLEDGEMENTS

All praises and thanks to Allah SWT 'The Almighty' for giving me easiness and strength to complete this study. I am also wish to express special thanks to my beloved father Purnomo Shidi Utomo, my beloved husband Bayu Prayudha, my lovely son Satyaprana Abbad Prayudha, my beloved sister Dhian Widya and Dhinie Utari, and all of my family members for all pray, support, encouragement and love. This thesis is hearthly dedicated for my mother in heaven.

I would like to use this opportunity to express my special gratitude to my supervisor, Professor Hideaki Goto, for his valuable guidance, advices, encouragement, and expertise and for his understanding extended to me. I also express my warm thanks for my examiner and the dean of GSIR in IUJ Professor Makoto Kakinaka, for his constructive suggestions during examination.

I am also thankful to The Scholarship Program for Strengthening Reforming Institutions Project for Indonesia for the financial support. My sincere thanks also go to Ministry of Home Affairs for giving the opportunity to pursue my master degree.

Finally, I also place on record, my sense of gratitude to all colleagues, who directly or indirectly, have helped me in this study. May the Almighty God richly bless all of you.

Depok, June 2015

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ABSTRAK

Nama : Dhina Mahariana Ningsih
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Judul : Dampak *spatial spillover* dari infrastruktur jalan terhadap pertumbuhan ekonomi regional di provinsi Jawa Barat, Indonesia

Tesis ini membahas probabilitas dari dampak *spatial spillover* dari infrastruktur jalan terhadap pertumbuhan ekonomi di provinsi Jawa Barat menggunakan data panel kabupaten/kota pada tahun 2007-2010. Studi ini menggunakan data Produk Domestik Regional Bruto (PDRB) sebagai indikator pertumbuhan ekonomi. Jalan dengan kondisi baik dan kepadatan jalan digunakan untuk mewakili infrastruktur jalan. Selanjutnya, tenaga kerja dan stok kapital swasta digunakan sebagai variabel kontrol. Penelitian ini menguji hipotesis bahwa infrastruktur jalan yang memadai tidak hanya akan memberikan efek positif pada pembangunan ekonomi suatu wilayah, tetapi juga terhadap wilayah di sekelilingnya. Untuk mengetahui adanya korelasi spasial dilakukan uji dengan menggunakan Global's Moran I index, hasilnya menunjukkan bahwa terdapat dependensi spasial antar kabupaten/kota di provinsi Jawa Barat. Penelitian ini menyimpulkan bahwa *spatial spillover* infrastruktur jalan memiliki dampak positif pada pertumbuhan ekonomi di tingkat regional.

Kata kunci:
spatial spillover, infrastruktur jalan, pertumbuhan ekonomi, provinsi Jawa Barat

ABSTRACT

Name : Dhina Mahariana Ningsih
Study Program : Graduate Program in Economics
Title : The Spatial Spillover Effects of Road Infrastructure on Regional Economic Growth in the West Java Province, Indonesia

This research examines the probability of spatial spillover effect of road infrastructure to regional economic growth in the West Java province by using data panel over 2007 to 2012 at regency's level. This study uses Gross Regional Domestic Product (GRDP) as indicator of economic growth. Good road condition and road density are utilized to explain road infrastructure. In addition, controlling variables use the labor force and private capital stock. This study tests the hypothesis that sufficient road infrastructure brings positive effect on economic development not only within region, but also on surrounding regions. The spatial correlation test by using Global's Moran I index results on the existence of spatial dependence among regencies on the West Java Province. The main results conclude that the positive spillover of road infrastructure on regional economic growth occurs in these periods at regional level.

Keywords:
spatial spillover, road infrastructure, economic growth, West Java province

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Road infrastructure plays an important role in supporting the economic growth of regions. It is inevitable that sufficient road infrastructure is required to achieve income surplus of the regions. Investment in road infrastructure is expected to boost economic activity, especially in reducing the distribution costs of goods, people and services to and from other cities. In addition, road infrastructure development will also address the unemployment wave, because it will need a lot of manpower. Hence, several studies in this area have utilized the production function to examine the effect of infrastructure on economic growth.

There are many empirical studies have found a positive relationship between the level of economic growth and the quality of infrastructure. The first pioneering research on impact of infrastructure on economic growth by Aschauer (1988) summarizes that infrastructure like roads, highways, irrigation systems, airports, sewage systems and mass transports have a positive impact on productivity. Barro and Martin (1995) summarize that most studies of economic growth consider the role of infrastructure and find positive effects by including infrastructure indicators as one of the independent variables in an economic growth model. In addition, Canning and Pedroni (2004) also conclude that in many cases infrastructure affects economic growth on the long run.

However, some studies find that the infrastructure does not affect economic growth, even result on negative impacts, depending on the context and methods conducted. Ghani and Din (2006) conclude that private investment has higher effect to accelerate economic growth than public consumption and public investment by using Vector Autoregressive models. In addition, Straub, Vellutini, and Warlters (2008) cannot discover the positive relationship between infrastructure on productivity and economic growth. Finally, the remarkable summary from the World Development Report (World Bank, 1994) shows that there is no effect of infrastructure on economic development in several cases. The vary results of this research area can be as a result of the different level of data utilized: national and

regional data, and ignoring the economic effect across regions (Banos, Gonzalez, and Mayor, 2013).

Road infrastructure does not only involve economic growth within a region, but also has impacts on the neighborhood regions. Moreno and Lopez-Bazo (2003) discovered that allocation with local infrastructures would have spillovers effects to other regions as well. Cohen and Morisson (2004) find that the effects created by public capital would not be restricted within a region. If spillovers exist, the regional data would be applied to estimate the effect of public capital its surrounding areas.

Additionally, Boarnet (1998) notes that the spillover effects are important because public endowments in a region may not affect only that region, but also other geographical units which are connected by a transport network. Cantos, Albert, and Maudos (2005) also find the existence of very significant spillover of transport infrastructure on economic development of regions. In other hand, Moreno and Lopez-Baso find the negative spillovers on infrastructure investment in Spanish provinces. The variance of the estimation probably because of the data definition and econometrics model that used is different. To come up with spatial externalities of transport infrastructure, spatial econometrics model has developed.

Yu, de Jong, Storm and Mi (2013) study the potential of spatial spillovers effects of transportation in China. They find the positive spillover effects on national level of transportation. Moreover, at the regional level, the effects of spatial spillover to neighboring regions range on positive, negative, and no effect to the regions. They determine economic growth of regions through some explanatory variables: labor, private capital, public capital exclude the transportation capital and transport infrastructure capital. In addition, there is another factor such as migrations affect the spillover among regions.

Banos, Gonzales, and Mayor (2013) study the impacts of road infrastructure on economic growth in Spain. They identify country's economic growth, labor force, human capital, private capital, and accessibility and modes of transportation for road transportation infrastructure variables. Moreover, they include the effect of spatial spillovers of road infrastructure to the economic growth. This paper concludes that there is a positive impact of a sufficient road to boost economic

development. However, the explanatory variables which to explain the road infrastructure effect in the study are limited.

There are some methods to analyze spatial dependencies among regions and to measure its spillover effects. Cohen (2010) describes several techniques to measure the broader benefit as a result from spatial interaction by using spatial spillovers (lags), spatial multipliers and spatial autocorrelation, which can be addressed in spatial econometrics method. By applying a cross section data set of production function model for the US manufacturing sector in 1996, this model shows that omitting a spatially lag dependent variable can lead to specification bias on the infrastructure parameter. In addition, Ramirez (2002) shows that spatial correlation among regions occurs on neighboring countries. The economic growth of a country is inevitably influenced by the performance of countries surrounding and effect of its location. The finding concluded that the spillover effect of nearest neighbors is necessary for economic growth, so that the spatial relationship should be considered in the economic growth analysis.

Most previous studies in this research area have tended to infrastructure in general; however, there have been a few researches into road infrastructure specifically. In addition, some previous studies have not given attention on spatial dependence on road infrastructure effect. This research contributes to the previous research by using data set from regency level of West Java province in Indonesia, so that I can estimate the spatial correlation among regions. Since most infrastructure research in this country are at province and country level.

1.2 Research Objectives

The general objective of this study is to assess the effects of road transport infrastructure on economic growth, in this case of the regency's level in the West Java province. Moreover, this paper also intends to estimate the spatial spillover effect of road infrastructure to the neighboring regions. This research study proposes two main questions. First, could the road infrastructures lead to more economic benefits on economic growth in regencies level?. Second, how do the road infrastructure of the region have positive spillover effect to the others?.

1.3 Paper Organization

The structure of this research is arranged as follows. The next chapter presents the overview of economic growth in Indonesia. Chapter 3 describes methodology, empirical models, and the dataset utilized. The results of the estimation and discussion are presented in Chapter 4. At last, Chapter 5 concludes the results and gives some recommendations for future research.

CHAPTER 2
OVERVIEW OF THE ECONOMIC GROWTH OF INDONESIA

World economic has grown slowly at last few years which affects the Indonesian economy. Nevertheless, Indonesian economy has increased although not significantly. This chapter will discuss about the condition of Indonesian economy recently.

2.1. Economic Growth

Global economic conditions have impact on the economic growth of Indonesia. The world crisis in late 2008 has result on the slow growth of Indonesian economy. However, spending in Indonesia's domestic market continues to sustain growth remain high. If Indonesia can strengthen the foundation of the economy and strengthening the investment climate, Indonesia can push back the growth rate is higher and more rapidly (World Bank, 2014). In addition, Indonesia can increase the growth rate through maximize export commodity. Moreover, improving technology and infrastructure hopefully can reduce the obstacles the distribution of goods and services among regions.

In the midst of a very sharp decline in the global economy on 2008 which hit the USA and Europe. The Indonesian economy was still able to show a good performance by recording a growth rate of 6.47 percent in 2008 , although slightly lower than in 2007, which grew by 6.95 percent (Figure 2.1). Crisis began to be felt towards the end of 2008 and continued until 2009 with a growth of 5 percent. The decline in economic growth in Indonesia is better than the other countries whose growth is negative in this period. In addition, the Indonesian growth rate started to going up on the next year which reaches 6.6 percent on 2009.

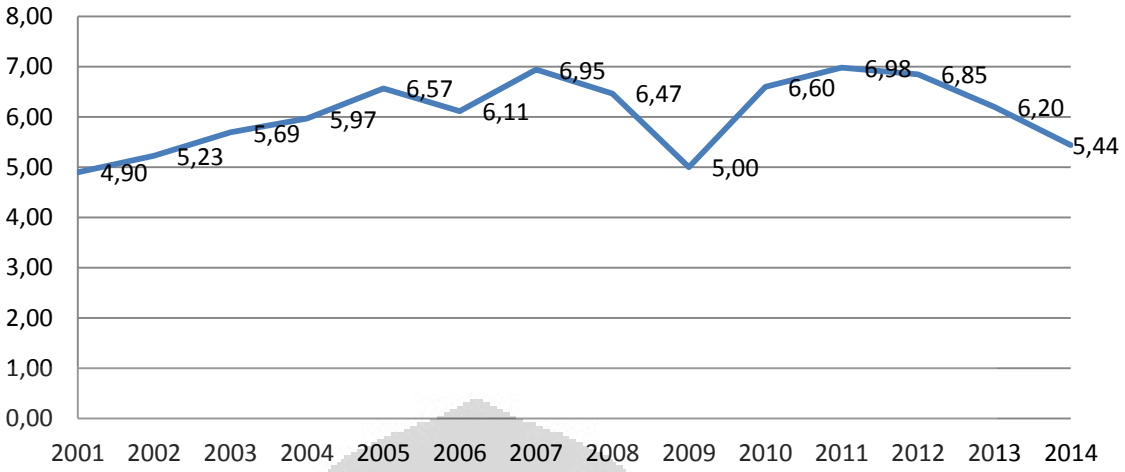

Figure 2.1 Gross Domestic Product growth rate of Indonesia 2001-2014 (in %)

Source: Processed from Statistics Indonesia data (2015).

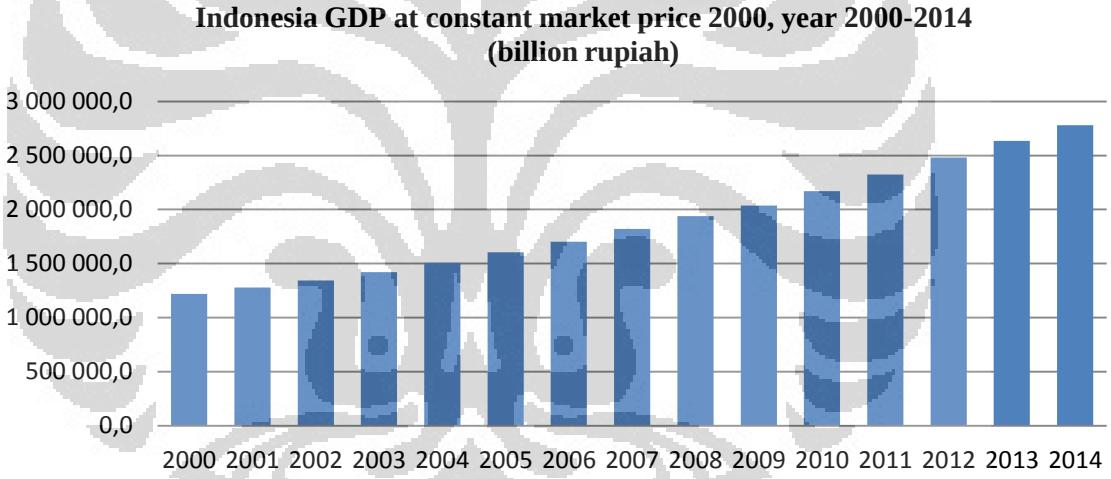

Figure 2.2 GDP of Indonesia at constant market price 2000, year 2000-2014 in billion rupiah

Source: Processed from Statistics Indonesia data (2015)

However, the real Gross Domestic Product of Indonesia experience increases gradually from year 2000 to 2014 according to Statistics Indonesia data (figure 2.2). Based on GDP real prices, it reached 2,777,064 billion IDR on 2014 from 1,218,334.1 billion IDR on 2000. Which means increase 1,560,729.9 billion IDR on last fifteen years.

Indonesia's economy in the future is expected to remain positive, even though still uncertain due to the prolonged uncertainty global economic. Master Plan for

the Acceleration and Expansion of Indonesia's Economic Development (MP3EI) as one of integral part of national planning which has released to cover the central government plans from 2011 until 2025, there are six corridor which present the regions of Indonesia : Java, Sumatera, Kalimantan, Sulawesi, Bali-Nusa Tenggara, Papua-Moluccas. It contains some direction to boost the Indonesian economic development, whereas one of the main priority sectors is a major investment in the infrastructure sector.

2.2. Road Infrastructure

Infrastructure is closely related to the economic growth of the region. However, various studies cited different results of infrastructure investment. In Indonesia, the relationship between infrastructure and economic growth statistically using a scatter plot shows a positive slope. This may imply that the increase on infrastructure investment has a correlation with the increase in overall economic output.

The development of road infrastructure has the more attention from the current government. Since the central government has commitment to improve the connectivity between regions to encourage economic growth. Ministry of Public Works (2015) states that in accordance with medium-term of national development plan 2015-2019, the central government has targets on the restructuring and constructing the sub national roads. Moreover, the budget allocation is divided in to construct the toll roads, maintenance of highways, build flyovers and underpasses, and support the subnational roads and national roads.

Figure 2. 3. GDP VS Road Infrastructure 1987-2012

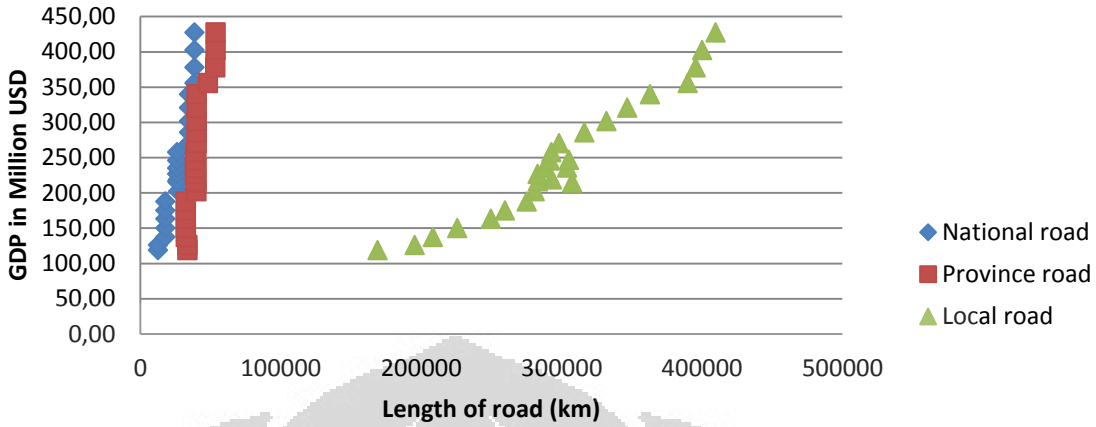

Figure 2.3 Comparison of Indonesia's GDP to length of road infrastructure on road categories over 1987 to 2012

Source : Processed from Statistics Indonesia data (2015)

It can be seen from figure 2.3 that the scatter plot graphs between Indonesia GDP and length of three categories of road: national, province and local road. Generally, the pattern shows increasing slope of dots from left to right, which means positive correlation between national gross domestic product and length of road. The local road which shows significant changes on that period of time may prove that local government has improved their services to public through transportation sector.

2.3. The West Java Province: Road Infrastructure and Economic Growth

The West Java province macroeconomic picture in this paper will be restricted from the output of the regional economy which represented by Gross Regional Domestic Product. From figure 2.4.it can be said that in general economic growth went up along 2001 to 2013 from 3.16% to 6.06%. However, the decline of growth rate occurred in year 2008-2009, in line with the felt of National GDP at these years as result of uncertainty global economic condition.

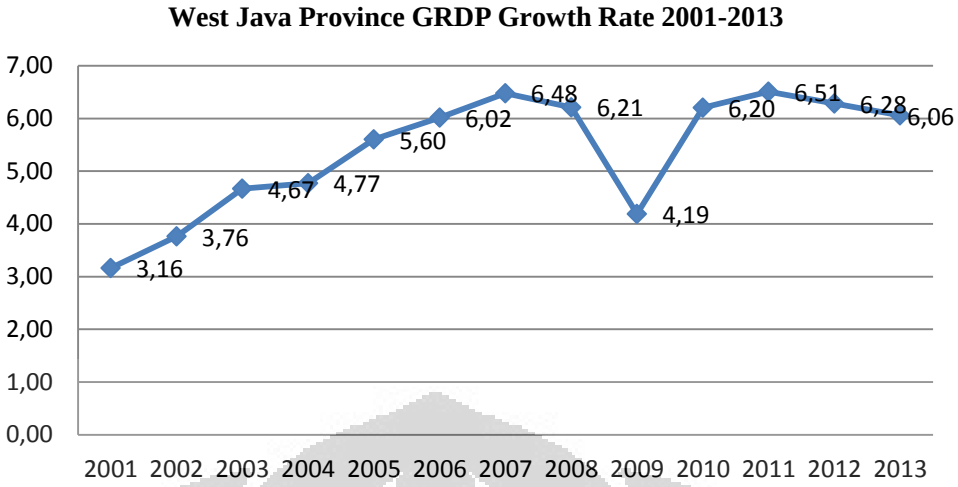

Figure 2.4 GRDP Growth Rate of the West Java Province 2001-2013

Source: Processed from Statistics Indonesia data (2015)

The West Java province is one of the provinces on the island of Java which has a positive growth rate. The West Java province ranks fourth after Jakarta, East Java, and Banten with economic growth rate as in the table 2.1. From the table below, the average of growth rate in 2003-2013 on the West Java province is 5.38%, under the national growth rate at 5.44%. While from the figure 2.5, it can be seen that on the GRDP at constant price, the economic output of the province shows increasing pattern over time to 2000 to 2013.

Table 2.1 Comparison of Economy Growth Rate in Java regions 2003-2013

Province	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average
DKI Jakarta	5.31	5.65	6.01	5.95	6.44	6.23	5.02	6.50	6.73	6.53	6.11	5.85
East Java	4.78	5.83	5.84	5.80	6.11	5.94	5.01	6.68	7.22	7.27	6.55	5.74
Banten	5.07	5.63	5.88	5.57	6.04	5.77	4.71	6.11	6.38	6.15	5.86	5.48
West Java	4.67	4.77	5.60	6.02	6.48	6.21	4.19	6.20	6.51	6.28	6.06	5.38
Central Java	4.98	5.13	5.35	5.33	5.59	5.61	5.14	5.84	6.03	6.34	5.81	5.25
Yogyakarta Special Region	4.58	5.12	4.73	3.70	4.31	5.03	4.43	4.88	5.17	5.32	5.40	4.73
Indonesia	5.69	5.97	6.57	6.11	6.95	6.47	5.00	6.60	6.98	6.85	6.20	5.44

Source: Processed from Statistics Indonesia data (2015)

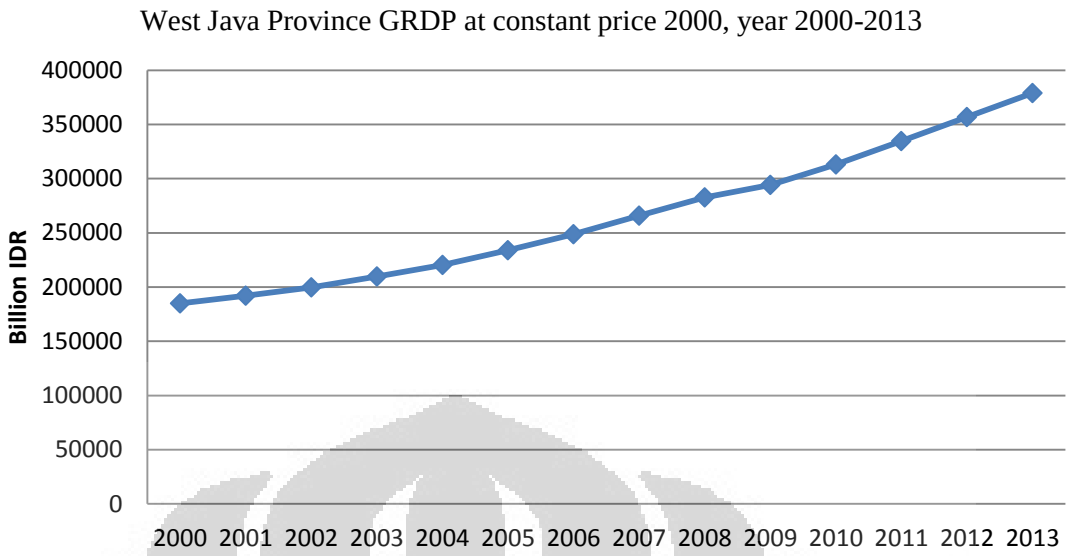

Figure 2.5 GRDP of the West Java Province at constant price 200, year 2001-2013

Source: Processed from Statistics Indonesia data (2015)

The West Java province is geographically adjacent to the national capital territory of Indonesia. In addition, it is one of the provinces that have a number of largest population, so that this region is needed an adequate road infrastructure to support their economy activities.

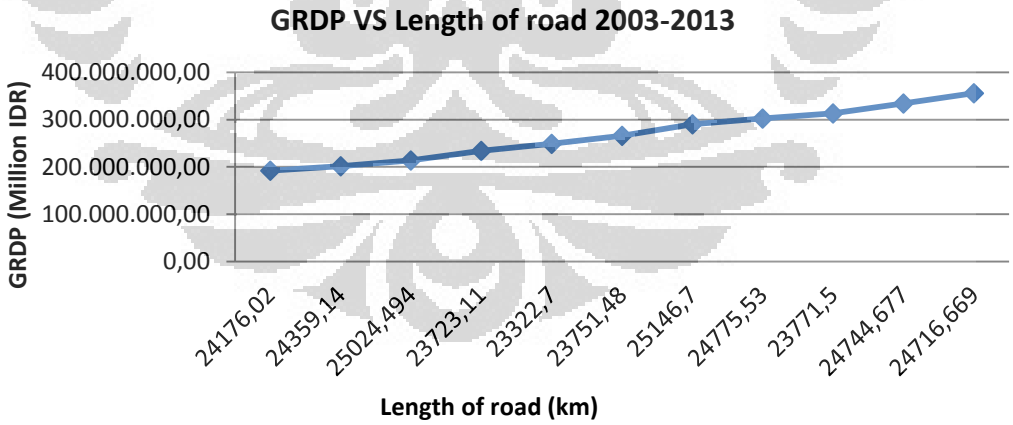

Figure 2.6 The comparison of GRDP to the total length of road on 2001-2013

Source: Processed from Statistics Indonesia (2015)

The figure above presents the correlation between the GRDP and the total length of road in the West Java province. Generally, it can be sum up that there is a

positive correlation between economic output and road infrastructure. Which it means that in every increase length of road in kilometers will raise the regional economic growth.

Infrastructure discussed here is the road infrastructure which is indicated by the length of the road network based on road conditions. There are four categories of road conditions used in this study: good, moderate, damage, and seriously damage. However, the number of vehicles is not included as an independent variable, due to the limited availability of data.

From the figure 2.7.it can be seen that in year period 2003-2013, the total length of road that has a good condition tends to increase. Otherwise, the moderate and damage categories have tended to decrease. Meanwhile, the length of road condition which has a seriously damaged categories increased gradually from 2009 to 2011, and then starts to decrease slowly from 2011 to 2013. Base on this pattern, this research will point out only on the road in good condition as a proxy of road infrastructure.

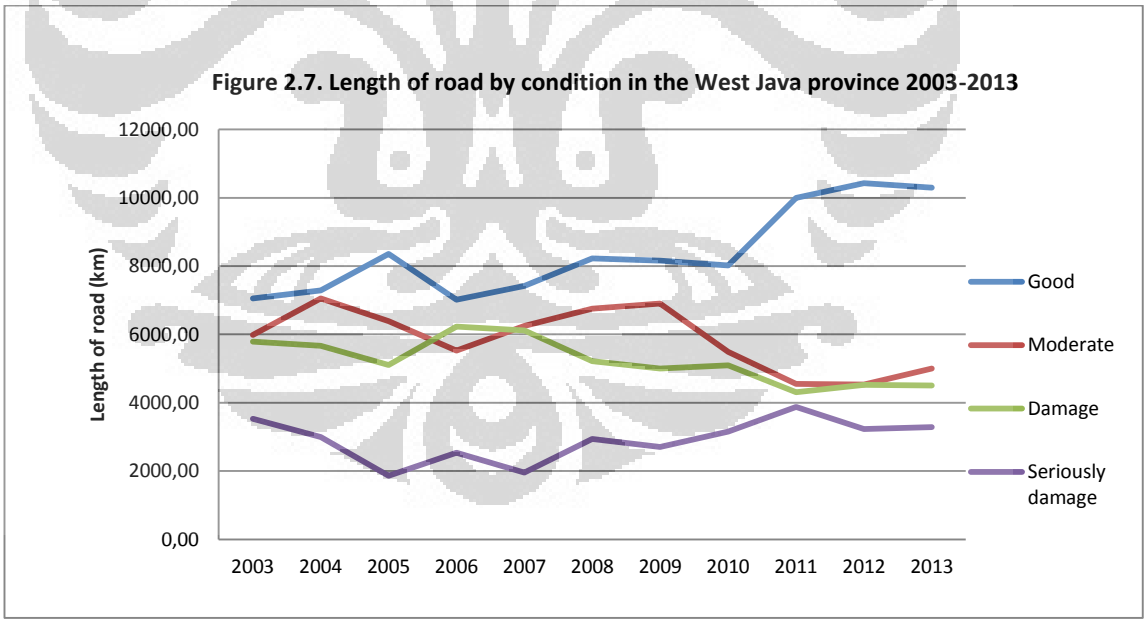

Figure 2.7 Comparison of total length of road in good, moderate, damage and seriously damage condition in the West Java province.

Source: Processed from The Statistics Indonesia data (2015)

CHAPTER 3
METHODOLOGY

3.1. Econometric Model

This paper assesses the effect of infrastructure on regional economic growth in the West Java province, Indonesia, at the regency level. The basic specification model used in this paper is based on the classical Cobb Douglas production model, which is the most common tool used to examine the economic productivity of public infrastructure. The approach is to utilize the production function as some previous work (Canning, 1999) has done, which is as follows:

$$Y_{it} = A_{it}K^{\alpha}_{it}H^{\beta}_{it}X^{\gamma}_{it}L_{it}^{1-\alpha-\beta-\gamma}U_{it} \quad (1)$$

Where Y is the real GRDP, A presents total factor productivity, K shows private capital, H *is* human capital, X is infrastructure capital, L represents labor force and U stands for term error, i is regencies index and t = time index. From the production function the relationship between road infrastructure and economic growth can be estimated.

This paper takes into account interregional relationships, which assumes that not only individual regency geographic characteristics but also those of surrounding areas, such as the regency's neighbors, influence economic growth. In this case, I argue that regency's growth rate will be related to the growth rates of its nearby regencies. In this line of analysis, I treat all regencies in West Java province by using the spatial econometric approach based on Anselin (1988) argument that spatial econometrics method deal with spatial dependence and spatial heterogeneity in regional level data set.

In this study, I estimate the impacts of transportation infrastructure on economic growth by using a model which has adopted from Boarnet (1995) :

$$lnY_{it} = \alpha_0 + \beta_1 ln\, L_{it} + \beta_2 ln\, K_{it} + \beta_3 ln\, Roadens_{it} + \beta_4 ln\, GR_{it} + u_{it} \quad (2)$$

$$lnY_{it} = \alpha_0 + \beta_1 ln\, L_{it} + \beta_2 ln\, K_{it} + \beta_3 ln\, Roadens_{it} + \beta_4 ln\, GRratio_{it} + u_{it} \quad (3)$$

Where:

- Y_{it} = Gross Regional Domestic Product for regency i in time t;

- L_{it} = Labor force for regency*i* in time *t*;
- K_{it} = Private capital stock for regency*i* in time *t*;
- Roadens = Road density for regency *i* in time *t*;
- GR = Length of good road for regency *i* in time *t*;
- GRratio = Ratio of length of good road to total length of road for regency *i* in time *t*;

The production function is then extended to include the effects of the neighboring regions, in order to observe the effect of road infrastructure of neighboring region on economic growth per regency. Then, the final empirical equation becomes:

$$lnY_{it} = \alpha_0+\beta_1 ln\, L_{it} + \beta_2 ln\, K_{it} + \beta_3 ln\, Roadens_{it} + \beta_4 ln\, GR_{it} + \beta_5 ln\, W{*}GR_{it} u_{it} \ldots \quad (4)$$

$$lnY_{it} = \alpha_0+\beta_1 ln\, L_{it} + \beta_2 ln\, K_{it} + \beta_3 ln\, Roadens_{it} + \beta_4 ln\, GRratio_{it} + \beta_5 ln\, W{*}GR_{it} u_{it} \quad (5)$$

Where *W* is a 26x26 spatial weight matrix.

Therefore, in the final model, the equation uses the spatial lag of road infrastructure variable. This is known to measure the spatial spillovers effect such as W*GR_{it}, where W is a 26 x 26 neighbor matrix with the elements W_{ij} (W_{ij}: 1 if regencies "i" and "j" are contiguous, otherwise W_{ij} = 0) (Anselin, 1988). This matrix is used to treat the physical contiguousness as the primary object for the presence of spatial spillovers. A matrix symmetric (W_{ij}) is used to provide information about the impact of road infrastructure quality on increasing economic productivity between regions.

According to Anselin (1988) weighted matrix (W) is purposed to estimate the spatial lag or spatial dependence. To measure the spatial autocorrelation, this research uses Global Moran's I Index. The index ranges between -1 and 1, which is classified as positive, negative and no spatial correlation. Positive spatial autocorrelation exist when Moran's I is close to +1 and the values are clustered together in the quadrant. In contrast, negative spatial autocorrelation occurs when the index is near -1. Otherwise, zero means no correlation between regions.

3.2. Data collection

The data set that will be utilized in this research are regional statistics data from the West Java province. I use the panel data set of 26 regencies and cities in the West Java from 2007 to 2012. The data set are compiled from two institutions: the Central Bureau of Statistics (BPS) and the Ministry of Public Works. The explanation about data set is utilized in this research are:

1. Growth Regional Domestic Product (GRDP)

   The GRDP data are GRDP at constant price year 2000. Based on the assumption that the GRDP at constant price presents the real GRDP. The data source is the Central Bureau of Statistics (BPS).

2. Labor Force

   The labor variable presents the number of labor force in each regency, which the sum of employment and looking for job categories. This variable is obtained from BPS.

3. Private Capital Stock

   The private capital stock estimates for each counties of West Java were calculated using technique described in Kataoka (2013). Which the private capital stock estimates for each regency of West Java is calculated from total capital stock in the manufacturing sectors.

4. Road Density

   The road density presents the availability of road in the regency. Which is measured by calculate the length of total road (km) divided by the large area of regency (km^2).

5. Road infrastructure

   Road infrastructure data are collected from the Ministry of Public Works and BPS. This data contains the road conditions which divided into roads in good, moderate, lightly damaged, or seriously damaged condition. This research only measure road in good condition as one of explanatory variables.

CHAPTER 4
RESULTS AND DISCUSSION

The main purpose in the research is to explore the linkage between road transportation and regional economic development in Indonesia, by using case in the West Java province. The hypothesis of this study is the road infrastructure will bring some positive impact on regional economic growth. In addition, the road infrastructure and economic output from surrounding regencies give positive impact on economic development of a regency.

Economic development of regions is estimated by using the Gross Regional Domestic Product (GRDP) which presented as GRDP. From table 4.1 which contains the descriptive statistics of variables use in this paper, it can be seen that the mean of absolute value of GRDP in this region is equal to 11,500,000 (million rupiah) out of 26 regencies. In this study, I present labor force as one of independent variables which affect economic growth, which have maximum value is 2,193,981 persons, whereas 0 (zero) means the data are not available on any years. Moreover, the private capital stock has high difference between the minimum and maximum value.

The road infrastructure in this research is described using proxy of variable road in good conditions. In addition, this study uses the road infrastructure spatial lag which shows the relation between W-matrix of regencies and the road infrastructure variable. The W-matrix contains the contiguous regencies, which is expected to explain how the adjacent regencies could affect the economy output of regency. The table 4.1 presents the difference value between maximum and minimum value for this variable is quite high. The statistics explain that minimum value of the spatial road infrastructure is 22.9 km, while the maximum value is 1377.426 km.

Table 0.1. Descriptive statistics of variables in the regression

Variable	Obs	Mean	Std. Dev.	Min	Max
GRDP	156	11500000	11700000	646324	61200000
Labor	156	733178.4	424919.9	0	2193981
Private capital	156	25470.34	68759.53	10.89342	383226.4
Road density	156	714.5027	1396.075	0	13190.29
Good road	156	330.3486	263.0616	0	1377.426
W*Good road	156	394.3714	222.5686	22.9	1377.426

4.1. The Spatial Pattern of Regional Economic Growth in the West Java Province

Interpreting the spatial distribution of GRDP among regencies is important to understand the connectivity of regions. There are several steps to do to know the spatial relationship among regions.

Firstly, build a weight matrix to know the spatial correlation among surrounding regencies. This study uses contiguity weight matrix based on the method the queen contiguity method, where neighboring regencies given a value of 1 and a neighboring regencies that have not directly contiguity given the value 0. The weight matrix in this research is 26 x 26 neighbor matrix since the number of regencies in the West Java province is 26 regencies and cities.

Secondly, the spatial correlation which shows the correlation among surrounding regencies is presented by Global Moran's I index. The Global Moran's Index results which close to 1 means that there is positive spatial dependence exist among regencies. This research tests the Global Moran's I on 2007-2012 in each year. The results show The Global Moran's I index of GRDP among regencies on 2012 is 0.1724 (I), while the expected value of the index (E) = Io = -0.0400. It can be concluded that the I > Io or 0.1724 > -0.0040 which means that spatial patterns GRDP of regencies in the West Java province have a clustered pattern. So, it can be assumed that there spatial dependence among in the West Java Province. Figure 4.1 shows that the spatial correlation of GRDP growth of regencies in this province increases over 2007 to 2012.

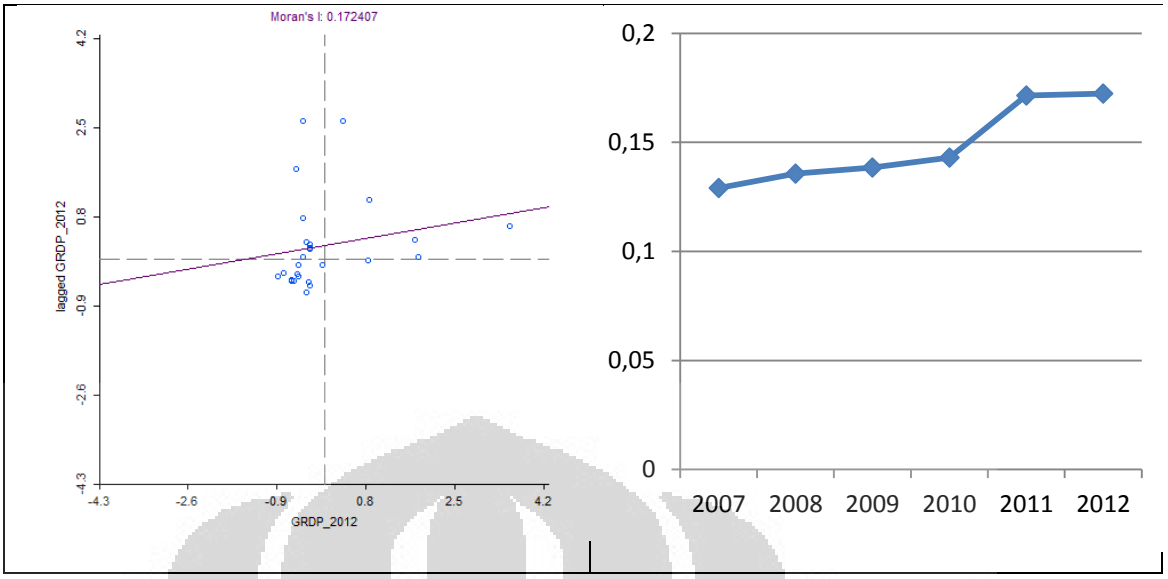

Figure 0.1 The Global Moran's I scatterplot on GRDP 2012 (left) and The Global Moran's I of GRDP of West Java regencies 2007-2012 (right)

4.2. Regression Result

This research explores four model regressions with different explanatory variables to see how road infrastructure has impact on regional economic growth. The results of the regression with using GRDP as a proxy of economic growth are presented in table 4.2. The variables which determine the regional economic growth use in this research are labor force, private capital stock, good road, road density and ratio of good road.

Before running some regression, some steps have done to find what the best method should use in the analysis. The best method should satisfy the best unbiased estimator (BLUE) which checked by multicolinearity, and heteroscedasticity. If the test results show that there is no problem above, so the OLS regression can be used in analysis. However, since the spatial dependence among regions exists, the common OLS could lead to bias in estimator (Mo, Chi, and Campbell, 2014). Dealing with this problem, this study explored the both model, with and without effect of road in surrounding regions.

The result of multicolinearity test in this research in any models shows the mean VIF value are less than 10. It means that there is no collinearity problem in the models. In addition, the test for checking heteroscedasticity results on the

probability >α. It can be sum up that the variables do not indicate heteroscedasticity problem. From these test result to check the BLUE of the models, it can be concluded that the variables use in this research can use in the regression.

4.2.1. The Effect of Good Road Infrastructure within Regencies

The first regression in this research applies the good road and ratio of good road within regions as an explanatory variable. The effect of good road condition within regions is explained as follows:

4.2.1.1. Model with length of good road as regressor

This model utilizes road in good conditions within regencies in Pooled OLS, Fixed Effect, and Random Effect. From the table 4.2, on simply Pooled OLS estimation, it can be interpreted that in every 1% increase in length of good road will increase regional economic growth by 0.092 %. This estimation has positive sign and significant at 10%. While, in every raise 1 % road density will affect economic growth 0.159 %. The sign of variable is positive and significant in 1%. The labor force has effect positive and significant to the regional output, whereas private capital stock does not influence significant. The R^2 values are 0.73 means that the explanatories variables utilize in the models affect higher percentage on the dependent variable, while the rest percentage, at around 30%, is affected by others variables which not included in the models.

Table 0.2 Regression with good road condition

Variable	Pooled OLS	FE	RE
Labor	0.9874***	0.2893**	0.5868***
Private capital	0.0130	0.0843***	0.0805***
Road density	0.1594***	-0.0010	0.0014
Good road	0.0922*	0.0456*	0.0463**
_cons	2.1444***	11.0798***	7.1540***
N	155	155	155
R-squared	0.7311	0.9897	0.6666
adj R-square	0.7239	0.9874	

*** significant at 1%
** significant at 5%
* significant at 10%
Number in parentheses are standard deviations

By using Fixed Effect regression, the result shows that in every increase 1 % of good road effect on raise 0.0456 % of economic growth. The sign of this variable is positive and significant on 10 %. While the road density result on not significant

and negative sign. Moreover the labor force and private capital stock influence the economic growth positive and statistically significant at 5 % and 1 %, respectively.

In addition, for comparison, the Random Effect estimation result presents on this research. From table 4.2, it can be seen that the good road condition impact positively and statistically significant to economic development. Moreover, road density has positive effect but not significant to the output. The other two economic variables: labor force and private capital stock have positive sign and statistically significant at 1 %.

4.2.1.2. Model with ratio of good road within region as regressor

The second model use ratio of good road ratio for the explanatory variable as a proxy of public capital in road infrastructure. In addition, this model utilizes the other independent variables which affect economy output: labor force and private capital.

The Pooled OLS regression results on that the ratios of good road have a high influence to economic growth. The result which presented in table 4.3 show that increasing 1 % in ratio of good road to total length of road within region will increase 0.671 % of regional economic growth. The sign for model with ratio of good road is positive and significant at 1%. While by road density show result in every 1 % grow of length of road to the large area will influence economic growth at 0.142%. This estimation give positive effect and significant at 1 %. Moreover, the labor's effect on this model is high, positive and significant to economic growth. An increase by 1% of labor will grow up economic growth 1.064%. In addition, the private capital has positive and significant at 10% on ratio of good road model, which in every increase 1% of private capital will affect increasing of economic growth at 0.0266%.

All independent variables have positive sign and significant effect on economic output on Fixed Effect model. The higher length of good road over the total length of road within region has positive relationship to economic output. Given 1% raise in ratio of good road increase regional economic growth 0.2252%.Whereas in this model, the road density has positive and significant on 1%. The other two independent variables are positively relates to boost economic growth.

Moreover, the Random Effect regression results are similar with the Fixed Effect results. All independent variables contribute positively to accelerate economic growth of regency. The highest contribution comes from labor force sector, while the road density gives the smallest effect on the growth.

Table 0.3 Regression with ratio of good road condition

Variable	Pooled OLS	FE	RE
Labor	1.0644***	0.2090*	0.6028***
Private capital	0.0266*	0.0819***	0.0810***
Road density	0.1429***	0.0408**	0.0354*
Ration of good road	0.6718***	0.2252***	0.1651**
_cons	1.2133*	12.3187***	7.1204***
N	155	155	155
R-squared	0.7537	0.9900	0.6855
adj R-square	0.7472	0.9877	

*** significant at 1%
** significant at 5%
* significant at 10%
Number in parentheses are standard deviations

4.2.2. The Effect of Good Road Infrastructure on Neighboring Regencies

The effect of spillover of road infrastructure on the surrounding regencies can be tested by using spatial lag of road infrastructure variables. This research explores the effect of good road within regencies to adjacent regencies.

4.2.2.1 Model with length of good road as regressor

This model tested the spillover effect of length of good road on surrounding regency to the economic output of regencies. This group of estimation runs the Pooled OLS, Fixed Effect, and Random Effect like the first two regressions. However, even the spatial spillover on road infrastructure varies on some previous research. I expected to have positive spillover of good road infrastructure to the surrounding area.

The first estimation by using Pooled OLS results on the positive effect of length of good road of surrounding regencies to the regional economic growth of regency. In every 1% increase of good road in surrounding regencies will lead to increase economic growth on 0.0153 %. However this coefficient results on not statistically significant, which mean it does not have significant impact on the output. While the other variables include in this model have similar result with the model without neighboring effect.

The second regression on Fixed Effect shows the positive spillovers among the adjacent regencies to the regional economic development. The sign for this estimation is positive on 1% level of significance. In every 1% rise of good road in neighboring regencies will result on increase 0.1251% of output. By using this model, the road density has negative sign, even though not significant in any level. Otherwise, the other economic variables remain same with the model without good road on surrounding.

Finally, the third regression which applies Random Effect estimates that the length of good road on adjacent regencies has positive externality to economic activity within regency. It can be seen on table 4.3 that the coefficient value is statistically significant on level 5%. The other independent variables use in the regression has positive sign.

Table 0.4 Regression with good road on neighboring regencies

Variable	Pooled OLS	FE	RE
Labor	0.9862***	0.2137*	0.5468***
Private capital	0.0116	0.0357*	0.0499**
Road density	0.1596***	-0.0002	0.0008
Good road	0.0925*	0.0358*	0.0381*
W*Good road	0.0153	0.1251***	0.0985**
Constant	2.0813**	11.8084***	7.4076***
N	155	155	155
R-squared	0.7312	0.9905	0.6763
adj R-square	0.7222	0.9882	

*** significant at 1%
** significant at 5%
* significant at 10%
Number in parentheses are standard deviations

4.2.2.2 Model with ratio of good road as regressor

The length of good road on surrounding regencies lead to decrease to economic growth on within regencies by using the Pooled OLS regression. The result which presented in table 4.4 show that increasing 1 % in length of good road on neighboring regencies will reduce 0.0325% of regional economic growth. The sign for model which includes the length of good road on surrounding regency has no significance at any level. However, the estimation of coefficient values of the other independent variables on this regression is similar to the previous model without considering good road in surrounding regencies.

The results through the Fixed Effect regression which include the effect of good road in neighboring regencies can be seen on table 4.4. The positive spillover of good road around the regency leads to positive relationship to the economic growth of regency. In addition, the road density has positive and significant effect on the economic development. Otherwise, the other economic variables include in this model are positively relate to the output, even though not statistically significant affecting the growth.

Moreover, this research measures the spillover effect of good road on surrounding area in Random Effect as comparison. The regression results show that positive spillovers exist as effect of length of good road on surrounding area. The statistical results show the effect of the variable is significant on 1% level of confidence. In addition, the other explanatories variables show the similar result as the previous model without spillover effect on the good road. The labor force and private capital stock have positive sign and significant effect to boost economic growth.

Table 0.5 Regression with ratio of good road on neighboring regencies

Variable	Pooled OLS	FE	RE
Labor	1.0669***	0.1381	0.5594***
Private capital	0.0298*	0.0331	0.0508**
Road density	0.1420***	0.0352*	0.0293*
Ratio of good road	0.6817***	0.2022**	0.1397*
W*Good road	-0.0325	0.1249***	0.0977**
Constant	1.3404	12.9439***	7.3872***
N	155	155	155
R-squared	0.7540	0.9908	0.6963
adj R-square	0.7458	0.9885	

*** significant at 1%
** significant at 5%
* significant at 10%
Number in parentheses are standard deviations

In order to choose which appropriate model should use, this research considers any test should have done. From all the tests have done, it can be summarized that the Fixed Effect model is more appropriate than Pooled OLS, since the probability > F = 0.000 in any models. Furthermore, to decide whether Fixed Effect or Random Effect should refer as the best model, this research should do another test which known as Hausman Test. The result of Hausman Test in any

models in this research show that the Fixed Effect is better than Random Effect since the probability <α. Moreover, the test to check better to use Pooled OLS or Random Effect results on better to use Random Effect. So that, it can be summarized that in this research, the model which use Fixed Effect regression give the best estimation for analyze the relationship between road infrastructure and economic growth. The R^2 value on the Fixed Effect regressions is higher than 0.9, which can interpret that the independent variables on the models have high influence to the dependent variable. While only less than 0.1% influenced by the other variables.

CHAPTER 5
CONCLUSION

5.1. Conclusion

This study purposes to examine the relationship between the road transportation and economic growth at regional level by using the panel data from 2007 to 2012 in the West Java Province, Indonesia. In addition, this study considers the influence of road infrastructure on surrounding regencies to the economic output of a regency.

In this research I pointed out at the effect of road infrastructure on the economic growth. In addition, I control the model by using some important variables which has effect on economic development such as labor force and private capital stock. Unlike many studies in this field on the West Java, I use the weighted matrix from regencies within the West Java province to see how neighboring regions have impact on increasing economic growth of regency.

Consistent with the hypothesis that road infrastructure has the positive impact on economic growth. This study results that the good road in the regions has positive and significant influence on economic output. However, the road density on this research has no significant effect on increasing regional economy. In addition, the positive spillover effect of road infrastructure on surrounding regencies exists on the regional level analysis.

The other two economic variables: labor force and private capital stock have positive and statistically significant influence economic growth of regencies in any models.

5.2. Limitations

There are three limitations in the results of study. The first is the sample size in this study includes only regencies and cities in the West Java province. While to analyze on regional level should be better use all regencies in Java Island. Therefore, the future research is suggested to cover all regencies in Java Island. Secondly, the limitation on the availability of controlling variables in regency level, which most data needed in this research are in province level. Thirdly, the validity

of data on the road in different conditions should be checked more, because in some cases the data source seems not present the real data.

5.3. Policy Implications

The development of transportation is important to accelerate economic growth of regions. Therefore, the investment in road infrastructure should have more attention from government. The implement of regional autonomy in 2001 implies on fiscal decentralization which resulted in the responsibility in maintaining road and building new roads are in local governments and the central government. The function of government level in this area depends on the role of road in national or regional, which has same purpose is to increase public services and economic growth of regions.

In line with the aim to improve the economic growth of road infrastructure received great attention from the current government. In order to enhance the level of the regional economy, the central government allocates more expenditure to boost infrastructure development such as for construction of highways and building many ports

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Appendix 1 Area and number of population of regencies/cities in the West Java province, Indonesia

Number	Regency/City	Area (km^2)	Population	
			2007	2012
1	Bogor	2997.13	4,316,236	4,989,939
2	Sukabumi	4160.75	2,258,253	2,408,338
3	Cianjur	3594.65	2,149,121	2,231,107
4	Bandung	1756.65	3,038,038	3,307,396
5	Garut	3094.40	2,429,167	2,481,152
6	Tasikmalaya	2702.85	1,792,092	1,722,514
7	Ciamis	2740.76	1,586,076	1,562,886
8	Kuningan	1189.60	1,140,777	1,056,275
9	Cirebon	1071.05	2,162,644	2,110,147
10	Majalengka	1343.93	1,204,379	1,189,191
11	Sumedang	1560.49	1,112,336	1,124,902
12	Indramayu	2092.10	1,795,372	1,696,598
13	Subang	2164.48	1,459,077	1,497,501
14	Purwakarta	989.89	798,272	882,799
15	Karawang	1914.16	2,073,356	2,198,978
16	Bekasi	1269.51	2,032,008	2,786,638
17	Bandung Barat	1335.60	1,493,225	1,563,389
18	Bogor city	111.73	866,034	987,448
19	Sukabumi city	48.96	300,694	308,508
20	Bandung city	168.23	2,364,312	2,461,931
21	Cirebon city	40.16	290,450	302,772
22	Bekasi city	213.58	2,084,831	2,448,291
23	Depok city	199.44	1,412,772	1,835,957
24	Cimahi city	41.20	518,985	560,659
25	Tasikmalaya city	184.38	624,478	653,085
26	Banjar city	130.86	180,744	180,030

Appendix 2 The West Java province map