EFFECT OF INFRASTRUCTURE ON ECONOMIC GROWTH IN SOUTH SUMATERA PROVINCE

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ABSTRACT

The aim of this paper is to study the effect of water supply infrastructure and electricity infrastructure which are considered as public utilities and road infrastructure which is considered as public works on economic growth in South Sumatera. I further extend the analysis to include the impact of infrastructure on three key sectors: agriculture sector, manufacturing sector and trade sector. In this paper, I use time series data from year 2001 to 2013. I measure economic growth as per capita GRDP. The approach is based on the growth model of Barro (1990). Infrastructure capital is an input into aggregate production. Using physical infrastructure as independent variables and employing Cobb-Douglas production function in the framework of Barro's growth model, the result provides clear evidence that electricity infrastructure and water supply infrastructure are significant and both positively affect per capita output in the province. This is also true in the agriculture sector, manufacturing sector and the trade sector. On the other hand, road infrastructure doesn't not show any significant impact. Overall, the results are consistent with the widely-accepted idea in policy research that infrastructure plays an important role in promoting growth, as well as with the viewpoint that certain conditions of the local economy may hinder the growth-related impacts of existing infrastructure.

Key words: Infrastructure, Gross Regional Domestic Product, Water Supply, Road, Electricity, South Sumatera

INTRODUCTION

The presence of sufficient infrastructure is essential for the modernization and commercialization of a nation's productive sector (for example agriculture sector) and the achievement of income surpluses and capital accumulation. It can provide a basis for the expansion of local manufacturing industries, as well as enlarging markets for the outputs of other industries (Srinivasu and Rao, 2013). According to Asian Development Bank Report, an adequate supply of basic infrastructure is an important determinant of the success of any nation's effort in diversifying its production base, expanding trade and linking together resources and markets into an integrated economy. It is an important driving force to achieve rapid and sustained economic growth. The higher affluence of the developed countries with advanced infrastructure bears testimony to this relationship (ADB, 2012).

Indonesia has been compared poorly in terms of the availability, both quantity and quality of infrastructure, though the latter is notoriously hard to gauge. The Global Competitiveness Report of the World Economic Forum 2010-11 ranks Indonesia 82nd out of some 140 countries in that regard. According to these perception-based indicators, the gap in infrastructure as compared with Southeast Asia is particularly manifested in roads and ports and, to a lesser extent, in railroads and air transport.

South Sumatera offers a unique opportunity to undertake this study. The first is the high economic growth experienced in South Sumatera Province from 2001 to 2013 and the ability of the key sectors to sustain this high growth performance. Second, a worrisome trend has emerged especially relating to the overall outlook of some of the state of physical infrastructures. This raise the question whether services derived from physical infrastructures can be able to sustain economic growth in the province as well as enhance the future growth prospect of the province's key sectors. In light of that, there are many studies conducted to analyze the impact of public infrastructure on economic growth, so it is theoretically as well as empirically proven that an economy cannot grow until its sectors (i.e.; agriculture, manufacturing and service) do not improve. Therefore understanding the extent to which infrastructures play in promoting GRDP growth in South Sumatera Province as well as its effect on the key sectors' output is key to generating long-term sustainable economic growth. This provides a unique opportunity to study the link between physical infrastructures and economic growth and further what drives the growth of key sectoral output.

Since 2001, one of the defining features of South Sumatra's growth has been agriculture-led growth supported by manufacturing and trade. Based on the graph in Figure 1 above, it can be concluded that South Sumatra's economic growth has been underpinned by these vibrant sectors. More precisely, in 2013 agriculture sector contributed 23.02 percent of GRDP, while manufacturing and trade sector contribute 17.15 percent and 18.11 percent respectively. This shows that South Sumatera should give more attentions to these three sectors in order to maintain local competitiveness and generate long term growth and prosperity for the province. Furthermore, apart from the other two sectors, agriculture is an important part of South Sumatra's economy, making a significant contribution to the province's exports and GRDP, and providing the largest number of jobs.

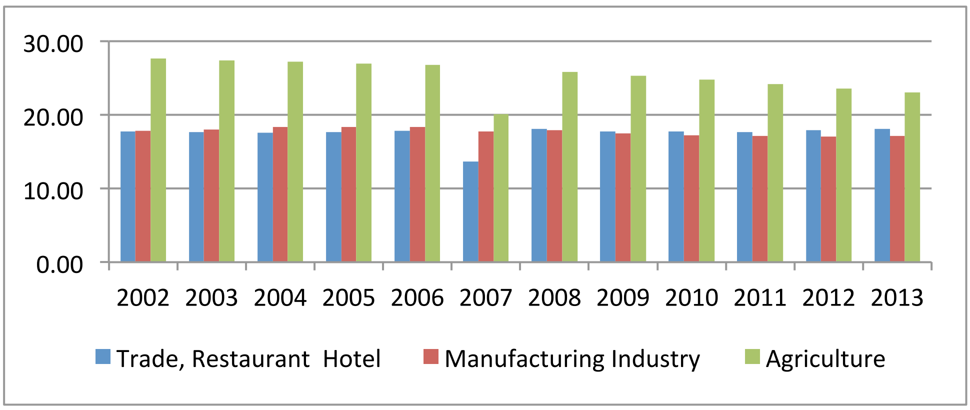

Figure 1. GRDP Share (%) by Main Sector in South Sumatera Province 2001– 2013
Data Source: Badan Pusat Statistik

However, empirical data shows clearly that the dominant sector which is agriculture sector share to GRDP growth has also been steadily declining over the years, as apparently shown by the graph above. This decline is also followed by manufacturing and trade sector. In agriculture, South Sumatra is home to some 70% of Indonesia's oil palm plantation area and 65% of natural rubber production, yet productivity is far below the productivity of its neighbors and competitors. This has been blamed on low seed quality and inadequate use of fertilizers but most importantly is the long transport times associated with increased transportation cost (Indonesia Provincial Commercial Business Opportunities Report, 2012)

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LITERATURE REVIEW

This section provides a succinct review of different economic theories on the role of public infrastructure, particularly its relationship with output or growth. It also serves as a background against which to build the economic model and select empirical approaches to use in this study. The empirical model with infrastructure capital is derived on the basis of the review.

Growth Theory

In traditional macroeconomic neoclassical growth theory, steady-state growth is driven by exogenous factors, that is, the dynamics of population and of technological process. This does not allow sufficient analysis of how firms' behavior as well as government policy actions (for example, government provision of infrastructures) may affect long-term growth through the impact on technological progress. As a result, the role of government in the growth process was underestimated in economic theory (Van Sinderen and Roelandt, 1998). However, as discussed below, new growth theory give a much greater role to public infrastructure in the growth and development process.

Neoclassical Growth Theory

In the traditional neoclassical growth model, steady-state growth is driven by exogenous factors implying that public infrastructure in particular can only affect the rate of growth during the transition to the steady-state. It can only be an important determinant of the level of output and is unlikely to have an important effect on the rate of growth (Easterly and Rebelo, 1993). More generally, broadly defined capital generates only internal and diminishing returns. Therefore, in the neoclassical view, the accumulation of infrastructure capital impacts on growth in the short run, with long-run growth entirely driven by exogenous technical progress.

The basic form of the neoclassical model is useful tool for understanding the factors that are associated with growth of output. Solow (1956) provides the framework and methodology to assess the importance of different factors. This is on the basis of assumption of competitive markets. In this framework, output is modeled as follows:

$Y_t = A_t \cdot f(K_t, L_t)$ where Y is level of output, K is private capital stock, and L is labor.

Technical progress, which is equivalent to the Solow residual or total factor productivity (TFP), is then defined as the difference between output growth and the share of the traditional inputs of capital and labor.

In this standard neoclassical growth accounting framework with only private inputs, any effect of public infrastructure will be included in TFP growth. Public infrastructure is therefore an accumulated input which is missed and contributes to an overstatement of true technical change. The neoclassical implication holds as long as diminishing returns to all capital exist (Stiroh, 2001). In neoclassical growth model, if infrastructure is considered to be a public good (that is, non-rival and non-excludable) any increases in its amount can be thought of as upward shifts of the production function, thereby raising the level of output as well as the growth rate of the economy in the transition to the steady-state (Edward, Paolo de Renzio and Stephanie, 2006).

Endogenous Growth Theory

The seminal papers of Romer (1986, 1990), Lucas (1988) and Barro (1990) have paved the way for the emergence of an entire class of endogenous growth models that seek to explicitly endogenize human capital accumulation and infrastructure as two of the main arguments of the aggregate production function. For Lucas (1988), the higher the productivity of each worker in the production of the final good, the higher the average level of human capital. In Romer (1986), knowledge is a production input with increasing marginal productivity. In Barro (1990), productive public services (particularly infrastructures) as inputs in private production and this further creates a positive linkage with the economic growth.

Endogenous growth analysis provides an endogenous mechanism for long-run growth. This is either through the removal of diminishing returns to capital or by analyzing specific actions that explain technical change. Therefore, factors affecting total factor productivity (TFP) include distortions from imperfect competition, externalities and reallocation effects.

At the core of endogenous growth models is the proposition that investment in capital (broadly defined) and the production of new processes and products is important for growth, if growth is to be continued without being affected by diminishing returns. The definition of capital is expanded to include many reproducible factors of production, such as accumulation of human capital training, build-up of know-how through Research and Development, spending on public infrastructure and other goods and so on (Van der Ploeg, 1994). This makes the assumption of constant (increasing) returns to scale with respect to the broad measure of capital quite plausible and it is through this channel that the important role that infrastructure can play in economic growth is highlighted (Barro 1990). These models therefore take into account the important role of that government policy can play in long-run outcomes through its impact on several growth including factors such as physical infrastructure, human capital development and enhancement of the functioning of markets (Crafts, 1996). Barro's model follows Rebelo (1991) by assuming constant returns to capital; **y = Ak,** where *y* is output per worker, *k* is capital per worker and A denotes the constant net marginal product of capital and greater than 0. Then the model is expanded by combining the government sector.

Barro argued that government role would consists of resources devoted to property rights enforcement, provision of public capital infrastructures and other activities that enter directly into production functions. Given constant returns to scale, the production function is $y = \varphi(k, g) = k\varphi\left(\frac{g}{k}\right)$ where φ fits the usual conditions for positive and diminishing marginal products. The variable k is measured as the per capita amount of aggregate capital, where as g represents productive inputs provided by the government that enters directly into the production function (for example, infrastructures).

Infrastructure-led channel of growth.

At the theoretical level, infrastructure could be modeled as having an effect on any given measure of output via two channels: *directly* as a third input in the production function and *indirectly* by influencing total factor productivity (Agénor and Moreno-Dodson, 2006). The theoretical literature has discussed a number of channels for these direct and indirect effects of infrastructures on economic growth as mentioned above.

Direct Effect

In a standard production function where factors are gross complements, an increase in the stock of infrastructure capital would have a direct, increasing effect on the productivity of the other factors. This is particularly clear if one thinks of cases of strong complementarities (Kremer, 1995), for example, if roads or bridges provide access to previously inaccessible areas, enabling productive investment there, or if improvements of the electricity or telecommunications networks make the use of certain types of machineries possible. But because infrastructure capital is also believed to generate important externalities across a range of economic activities, it is possible that its net effect is larger than expected from a simple factor accumulation effect. The theoretical literature has discussed a number of channels for these indirect effects.

Indirect Effect

The first one is maintenance, private capital durability, and adjustment costs. There is growing evidence that infrastructure policy is biased toward the realization of new investments at the detriment of the maintenance of the existing stock. The main reasons appear to be political economy ones. (Maskin and Tirole, 2006, and Dewatripont and Seabright 2006). As a consequence, the life span of the stock of both the infrastructure itself and of private capital that makes use of it such as trucks operating on low-quality roads or machines connected to unstable voltage lines is reduced, and operating costs increase (Engel, Fischer, and Galetovic 2009). The case of palliative private investments in devices such as electricity generators is an extreme example of this.

Second, infrastructure appears to have a microeconomic impact through a number of channels, including labor productivity gains resulting from improved information and communication technologies, reductions in time wasted commuting to work and stress, and improvements in health and education among others. Moreover, such improvements are likely to induce additional investment in human capital in the medium and long term (Straub 2008)

Finally, infrastructure may be the source of economies of scale and scope throughout the economy. For example, as roads and railroads improve, lowering transport costs, private firms benefit from economies of scale and more efficient inventory management (Li and Li 2009). Similarly, enhanced access to communication devices, as was the case across the developing world in the last 2 decades with the growth of mobile telephony, is likely to result in efficient market clearing and enhanced competition as a result of improved information flows (Jensen 2007).

Previous Research

Infrastructure and Economic Growth

Pravakar, Ranjan and Geethanjali (2012) studied the effect of physical infrastructure on economic growth in the

People's Republic of China over the period 1975 – 2007. In their study, they computed physical infrastructure index with six sub-headings which are as follows: electric power consumption per capita, pave road as percent of total road, energy consumption per capita, telephone lines per thousand, railway line per thousand, the number of people using airway. Within this study, distributed lag autoregressive approach and generalized moments methods are used and Granger causality tests are carried out. In accordance with the findings, it is seen that developing infrastructure has a tremendous effect on growth. Infrastructure investments have a greater impact than the investments of public and private sector. There is a one-way causality link from infrastructure stocks to growth and a two-way causality link from infrastructure stocks to public-private sector investments

Stéphane and Akiko (2011) used physical indicators for four different sectors (telecommunication, electricity, road, and water) and applied two distinct approaches—growth regressions and growth accounting—to analyze the link between infrastructure, growth, and productivity in developing Asian countries over the period 1971 - 2006. The main conclusion is that a number of countries in developing Asia have significantly improved their basic infrastructure endowments in the recent past. This improvement appears to correlate significantly with good growth performances in terms of GDP per capita. However, the evidence seems to indicate that this is mostly the result of factor accumulation, a direct effect, and that the impact on productivity is rather inconclusive.

Hong, Chu and Qiang (2011) studied the relation between transportation infrastructure and regional economic development comprising 31 regions in China in years 1998-2007. In accordance with the results of the study in which panel data method was used, it was seen that highway and drinkable water infrastructure had significant effects on growth. However, there was a positive effect on growth even in the regions where the highway infrastructures were low. Whereas water infrastructure had positive contribution to growth only when a certain amount of investment was actualized.

Study by Fedderke and Bogetic (2009) utilizing panel data for South African manufacturing over the 1970-2000 period, and a range of 19 infrastructure measures, isolates the impact of endogneity. The paper develops an instrumentation strategy generalizeable to other contexts. In their study, controlling for the possibility of endogeneity in the infrastructure measures renders the impact of physical infrastructure capital not only positive, but of economically meaningful magnitudes.

Seethepalli, Bramati and Veredas (2008) employ physical measures of infrastructure that are electricity production per capita (KWh), kilometers of paved road per capita, water as percentage of population with access to improved water source, and sanitation as percentage of population with access to improved sanitation facilities. They do find a positive effect of all dimensions of physical infrastructures on growth, using standard growth regressions in a panel of 16 East Asian countries at 5-year intervals. They also conclude that these significant effects vary with a number of country-level characteristics. For example, in the water sector however, it appears that a certain threshold of income needs to be crossed (i.e., the transition from low to medium income) before the benefits of increasing water sector infrastructure begin to increase as the country's income level rises further. However, the elasticity of GDP with respect to roads is higher in poor countries (0.29) than in medium income countries (0.15), which in turn is higher than in high-income level countries (-2.6).

Estache, Speciale, and Veredas (2005) studied 48 Sub-Saharan African Countries over a 25 year period from 1976 to 2001. They consider five measures of physical infrastructures that reflect 5 key sectors: telephone mainlines in per 1 000 people, electricity consumption in kilotons of oil equivalent per capita, and roads kilometers of paved roads per capita, water percentage of population with access to an improved water source and sanitation percentage of population with access to improved sanitation facilities. Using augmented Solow growth model, all the infrastructure variables, except sanitation, significantly affect GDP per capita, after controlling for education and total investment.

Calderon and Serven (2004) brought another dimension into the literature by considering qualitative and quantitative measure of physical infrastructure. They examined the effects of infrastructure stock on economic growth and income distribution by using panel data method. The study involved 100 countries and the period of study is 1960-2000. The infrastructure variables used to developed quantitative index covers telecommunication sector (number of main telephone lines per 1,000 workers), the power sector (the electricity generating capacity of the economy —in MW per 1,000 workers), and the transportation sector (the length of the road network —in km. per sq. km. of land area). Data for qualitative index includes telecommunications (waiting time for telephone main lines), power (the percentage of transmission and distribution losses in the production of electricity), and transport (the share of paved roads in total roads). The empirical strategy involves the estimation of simple equations for GDP growth let alone a variety of GMM estimators based on both internal and external instruments, and report results using both disaggregated and synthetic measures of infrastructure quantity and quality. In accordance with the results achieved from the study, both qualitative and quantitative infrastructure index affect the growth in a positive manner and reduce the unfair distribution of income.

Mauritz (2002) analyze the Contribution of Infrastructure on Indonesia Economic Development. Using panel data from 26 provinces in Indonesia from year 1983 to 1997 and including infrastructure of road, electricity and telecommunication, the result indicates that infrastructure in general will increase growth substantially, where he found that infrastructure of electricity has the highest contribution on growth and the elasticity of electricity is higher than elasticity in investment of non infrastructure. Considering geographic condition by looking into the effect of infrastructure in each region, Mauritz conclude that the centralized development policies in Java Island create disparities of income in each region in Indonesia, especially between Java Island and outside Java, even though at the same time the economic developments were exist. Economics development in Java Island is significantly higher compare to other regions in Indonesia (Mauritz 2002).

Based on Ugandan data, Deininger and Okidi (2002) find that access to key public goods, such as electricity, critically determine households' ability to increase its income and contribute to economic growth. Their results show that households with access to electricity had higher incomes (3.5 percentage points) and expenditures (6 percentage points) than those who had no such access. In addition, multinomial log it regressions show that households with electricity access had a 20 % higher chance of not falling into poverty and contribute to economic growth than those that did not. As Deininger and Okidi (2002) explain, this effect most likely emerges due to the indirect effects of electricity availability (e.g. higher demand for labour) which enhanced households' ability to participate in economic activities through reduced households' vulnerability to poverty.

Focus on road and water infrastructures, Lewis (1998) investigates on the impact of road and water infrastructure on Municipal Economic Development in Kenya. He concludes that road and water positively and significantly impact on economic growth. Lewis makes further analyze and concludes that "the influence of water infrastructure appears to be greater than that of road, at least marginally, in terms of its impact on economic growth" (Lewis 1998). As there are two institutions who provide water services; local authorities and central government/water Corporation, this paper also look into the effect differences of institution on the quantity or quality of infrastructure. Kenya's urban public infrastructure is widely known to be inadequate in number and / or quality. In this regard, recent attention has focused on the road, in particular, and water services, to a lesser extent. Using data of 32 municipalities in Kenya, the paper measures economic development as a function of human capital, labor and index of public infrastructure which in this case is water and road. To check the bias, this paper check for possibility of causal effect of infrastructure and development run in both direction using Haussmann test, then the result shows that there is no specification bias, therefore, simultaneous equations approach is unnecessary for estimating the influence of public capital stock on incomes (Lewis 1998). The main results of this paper shows that "water appears to be more important in stimulating growth than does road infrastructure in Kenya at present" (ibid).

Infrastructure and Sectoral Outptut

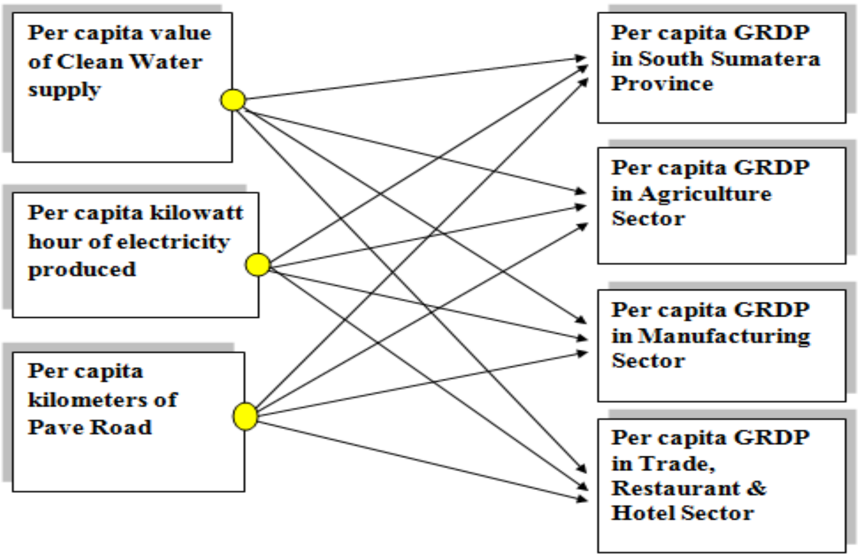
Empirical evidence, however, indicates that public infrastructure may have different effects in different sectors. For example, the impact of infrastructure on three sectors of the economy (Services, Agriculture & Manufacturing) was studied by Rioja (2004) by using panel data of seven Latin American countries in 1960s and 1990s and found that the countries that are in developing phase have the greatest gain if investment in infrastructure is raised in 1960s and in 1990s service sector benefited more from additional investment in infrastructure. Sturm (2001) finds infrastructure had a higher positive effect in the service sector than in manufacturing and agriculture in the Netherlands after the Second World War. Feltenstein & Ha (1995) test the effects of infrastructure on costs in 16 sectors of the economy of Mexico. They find the effects can vary significantly among sectors. Morrison & Schwartz (1996) and Nadiri & Mamuneas (1994) find positive effects on manufacturing in the US. This empirical evidence provides the motivation to extend the theoretical literature to a multi-sector model. This paper extends the theoretical literature by studying the effects of public infrastructure in the three sectors of South Sumatera Province: agriculture, manufacturing, and services.

Based on the earlier research, it is clearly seen that the correlation between infrastructure and economic development is quite high. Most of the research found that infrastructure positively affects economic growth. As we can see from the earlier research, infrastructure that frequently been discuss or analyze are infrastructures of road, telecommunication, electricity, water and sanitation.

This paper will contribute to the literature by studying the link between physical infrastructures and economic growth and extends this relationship to include the effect of physical infrastructures on the contribution of three key sectors in South Sumatera Province: agriculture sector, manufacturing sector and trade or services sector.

Research Model

The following analysis builds on this earlier work and treats physical infrastructures as an input whose services enhance the availability of physical output of infrastructure and consequently on economic growth. Therefore based on theories and intuition given, the conceptual model is formulated below



Statement of Hypothesis

The following hypothesis will be subjected to empirical testing:

Hypothesis 1

Per capita value of clean water supply, per capita kilowatt hour of electricity produced and per capita kilometers of paved road have a significant influence on per capita GRDP in South Sumatera Province.

Hypothesis 2

Per capita value of clean water supply, per capita kilowatt hour of electricity produced and per capita kilometers of paved road have a significant influence on per capita GRDP in agriculture sector, per capita GRDP in manufacturing sector and per capita GRDP in trade sector.

RESEARCH METHOD

Scope of the Study

This analysis will focus primarily on datas relating to (APBD) figures. Therefore this encompasses all datas provided by the provincial government. This study looks at physical infrastructure that acts as productive inputs, that is, public inputs assumed to be growth enhancing (for example, road). In this manner of approach, this paper will try to analyze the impact of physical infrastructures as public utilities which are represented by water supply and electricity and as public work which is represented by road. These physical infrastructures are also ranked as some of the most binding constraint to economic and socio-inclusive growth (KPPOD 2008).

Data Source

The data used in this research will consist of secondary data. Data on growth rate of real gross regional domestic product in South Sumatera Province, GRDP in agriculture sector, GRDP in manufacturing sector and GRDP in trade sector, length of paved road, value of clean water supply and electricity produced will be taken from Badan Pusat Statistik (BPS) database, unless specified otherwise. The study period is from 2001 to 2013.

Sample Size

For the purpose of this study, the sample observation will cover the period 2001-2013 for South Sumatera Province.

Description of Variables

The objective of this paper is to study the effect of physical infrastructure on GRDP growth in South Sumatera as well as GRDP in three of the sectors in the province from 2001 to 2013. In doing so, this paper will use time series data. The variables of interest are roads, water supply, and electricity. Most of the data is secondary data and will be taken from Statistics Indonesia from various years. Those variables are explained in details as follow:

(i) **Gross Regional Domestic Product (GRDP)**

GDP is an indicator that depicts value added in a region for a certain period. In this research, data for economic growth in South Sumatera Province is measured using Gross Regional Domestic Product (million rupiahs). At the sectoral level, the study used GRDP in agriculture sector (million rupiahs), GRDP in manufacturing sector (million rupiahs) and GRDP in trade, restaurant and hotel (million rupiahs). GRDP is provided in the constant price with year 2000 as the base year, and is divided by mid-year population to express in per capita terms.

(ii) **Road**

Roads are terrestrial infrastructure including any part of road and supplementary infrastructure designated for the traffic. Most of the distribution of goods and the mobility of capital equipment and labor are highly depended on road network. In this paper, kilometers of paved road are used to measure road infrastructure. These are referred to as asphalted roads and are sealed with tar. Data is divided by the mid-year population to express in terms of per capita.

(iii) **Water**

In this paper, water supply is the value of clean water that is consumed by whole population. Water is one of the basic needs for human. Moreover, many industries depend on water in their production process. The data is value of clean water supplied (million rupiahs). Data is divided by the mid-year population to express in terms of per capita.

(iv) **Electricity**

Electricity is believed to be one component that influences productivity. Moreover, most economic activity is highly dependent upon electricity input. In this study, electricity produced and distributed (KWh) is used as a proxy for services provided by electricity infrastructure.

Technical Analysis

To fulfill the objectives of this study, the ordinary least squares method of data analysis will be applied. Therefore analytical models are developed in a manner consistent with the overall research framework. Basically the empirical approach is an extension of the endogenous growth theory utilizing the direct role of public capital and its impact on economic growth. Model approach used in this paper is following the theoretical proposition by Barro (1991) about The Contribution of Public Infrastructure Capital to Aggregate Output.

Therefore following the argument proposed by the endogenous growth theory, the first model studies the link between GRDP growth in South Sumatera Province and physical measures of public infrastructures: electricity, road and water. The second, third and the fourth model extends the infrastructure-augmented growth model to include sectoral contribution to GDP growth and therefore examines the extent to which physical infrastructure affects sectoral output.

The regression model is given by:

Model 1
$LnGRDP = b_0 + b_1\ LnELE + b_2\ LnWATER + b_3\ LnPAVE + e$
Model 2
$LnGRDP_{Agri} = b_0 + b_1\ LnELE + b_2\ LnWATER + b_3\ LnPAVE + e$

Model 3
$LnGRDP_{Manuf} = b_0 + b_1\ LnELE + b_2\ LnWATER + b_3\ LnPAVE + e$

Model 4
$LnGRDP_{Trade} = b_0 + b_1\ LnELE + b_2\ LnWATER + b_3\ LnPAVE + e$

where;
LnGRDP = ln value of per capita gross regional domestic product in South Sumatera Province
$LnGRDP_{Agri}$ = ln value of per capita gross regional domestic product in agriculture sector
$LnGRDP_{Manuf}$ = ln value of per capita gross regional domestic product in manufacturing sector
$LnGRDP_{Trade}$ = ln value of per capita gross regional domestic product in trade sector

LnELE = ln value of per capita KWh of electricity produced
LnPAVE = ln value of per capita kilometers of paved road
LnWATER = ln value of per capita clean water supply
b0 = constant term
b1, b2, b3 = coefficients to be estimated
e = disturbance term

From the equation above, the positive sign of the coefficient for independent variables represent that there is positive relationship between these variables and dependent variables. If there is an increase in any of these variables, these will lead to an increase in the dependent variables. In contrast, if any of these variables have a negative sign, it will not help to promote growth in the province. The variables are transformed into natural logarithm as expressed above.

RESULTS
This chapter is concerned with data presentation and analysis. It further interprets and discusses the findings of the analysis carried out. From the inferential results, we can be able to make decisions about the various hypotheses under study

Data Presentation
Table 1. Data for the Variables under Study

Year	LnGRDP	$LnGRDP_{Agri}$	$LnGRDP_{Manuf}$	$LnGRDP_{Trade}$	LnELE	LnPAVE	LnWATER
2001	1.63863	0.145562	0.407031	0.065673	-2.197862	-8.295088	2.135231
2002	1.755802	0.453597	0.537591	-0.106797	-2.189339	-8.23512	0.878463
2003	1.834283	0.533272	0.647074	0.013244	-2.17214	-8.262409	2.279202
2004	1.925704	0.634013	0.726858	0.139744	-2.102115	-6.674962	2.22755
2005	2.054705	0.753952	0.972561	0.292498	-2.050922	-7.572062	2.617264
2006	2.219541	0.919208	1.172481	0.461013	-2.030217	-7.773906	2.594011
2007	2.367466	1.050983	1.282278	0.610009	-1.984052	-7.770402	3.265944

2008	2.522851	1.170835	1.462911	0.805526	-1.863787	-7.778511	3.291072
2009	2.609106	1.193849	1.502772	0.88761	-1.822643	-8.437607	3.477008
2010	2.739504	1.311894	1.539364	1.006839	-1.77754	-8.544052	3.541221
2011	2.877616	1.419132	1.596516	1.140081	-1.613787	-1.696524	3.649853
2012	3.016704	1.489717	1.684743	1.295486	-1.488992	-8.691034	3.902573
2013	3.137545	1.572525	1.775899	1.440458	-1.389914	-8.624561	3.898208

Data Analysis and Interpretation

Infrastructure and economic growth in South Sumatera

Table 3 below presents regression results based on the data for South Sumatera Province. Economic growth proxied by per capita GRDP was regressed against three proxies of physical infrastructure variables: per capita electricity produced, per capita kilometers of paved road and per capita value of clean water supply. As can be seen in the table, the coefficient of electricity (LnELE) is positive and statistically significant at 1% level of significance. Therefore the result supports hypothesis 1 which states that per capita electricity produced has a significant influence on the per capita GRDP in South Sumatera. The interpretation is that if per capita electricity produced increase by 1 percent, economic growth proxied by per capita GRDP will increase by 1.37 percent.

The coefficient of water supply turns out to be positive and statistically significant at 5% level of significant. Hence the result does support hypothesis 1 which states that clean water supply per capita has a significant influence on per capita GRDP. Therefore if the value of clean water supply increases by 1 percent, per capita GRDP will increase by 0.15 percent

Table 2. T –test result for infrastructure and per capita GRDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.520323	0.601790	7.511458	0.0000**
LnELE	1.369262	0.220388	6.212968	0.0002**
LnWATER	0.156093	0.067199	2.322852	0.0453*
LnPAVE	0.001632	0.016481	0.099039	0.9233

$R^{2} =$ 0.967483 *** = 5% level of significant ** = 1% level of significant**

Road infrastructure which is proxied by per capita kilometers of paved road shows different results. The coefficient is positive as expected but is statistically not significant. Therefore there is strong evidence to reject hypothesis 1 which states that per capita kilometers of paved road has a significant influence on per capita GRDP

.Overall, the result shows a positive relationship between economic growth and electricity infrastructure as well as water infrastructure. However, using paved road as a proxy for physical infrastructure produces statistically insignificant relationship with economic growth.

The constant or intercept of the model has a positive value of 4.520323. This implies that the expected value on the dependent variable will be equal to the constant when explanatory variables are set to 0 (Gassoumis, 2012). Thus, if the independent variables are given to be equal to 0, economic growth will be equal to 4.520323 since the p-value is significant at the 1% level of significant.

R-square has a limit value of 1, and it happens when the regression line fits the observations exactly. The overall fit of the estimated regression equation to the actual data will be "better" if R-square is closer to the value of 1. For time series data R-square of .5 might be considered as a reasonable good fit for the model (Baye, 2005). In this research paper, the coefficient of determination R^2 (0.967483) indicates that approximately 97% of the variations in the regressand is explained jointly by the regressors. However, the rest of the variation is due to factors other than the independent variables or residuals.

Infrastructure and Sectoral Effects

Services derived from the physical infrastructure can also have a significant effect on the productive sectors of the economy. ADB (2012) states that physical infrastructures like roads, electricity and water infrastructures can have a clear impact on increasing employment and productivity in both the agriculture and non-agriculture sectors. Growing opportunities for employment and higher returns to working can enhance aggregate supply, thereby lowering living costs and helping raise real incomes and standards of living, leading to sustainable economic growth and poverty reduction.

Therefore, in this study, I expect to find evidence that the sectoral contribution to GRDP are depending on road, electricity and water supply infrastructure.

Infrastructure and Per capita GRDP in Agriculture sector

Table 4 below depicts the regression results for infrastructure variables and GRDP in agriculture sector. As in the preceding regression analysis, the annual agriculture share in real GRDP per capita is regressed against three measures of infrastructure development. Based on the results, electricity infrastructure exerts a positive impact on per capita GRDP in agriculture and is statistically significant at 1% level. Therefore we accept our hypothesis 2 which states that percentage of household access to state electricity has a significant influence on per capita GRDP in agriculture sector. The interpretation is that if per capita electricity produced increase by 1 percent point, per capita GRDP in agriculture will increase by 1.03 percent.

The coefficient of water supply per capita also has a positive sign as expected. This depicts positive relationship with per capita GRDP in agriculture. Empirical evidence shows that this relationship is statistically significant. Therefore we support hypothesis 2 which states that value of clean water supply per capita significantly influence per capita GRDP in agriculture sector.

The coefficient of kilometers of paved road per capita has a positive sign as expected. This implies a positive relationship between paved road and per capita GRDP in agriculture. However, empirical evidence shows that this positive correlation is statistically not significant. Hence, we reject hypothesis 2 which states that kilometers of paved road per capita has a significant influence on per capita GRDP in agriculture sector.

Table 3. T-test results for Infrastructure and Agriculture sector

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.490840	0.929715	2.679143	0.0252*
LnELE	1.033777	0.340480	3.036232	0.0141**
LnWATER	0.174270	0.293817	2.678634	0.0175**
LnPAVE	0.008087	0.025461	0.317605	0.7580

$R^2 = 0.900841$ Prob. (F-statistic) = 0.000075

*** = 5% level of significant **= 1% significant level**

Meanwhile, the intercept term is positive and statistically significant at 5% level of significant. This implies that if all the coefficients are set to 0, then the per capita GRDP in agriculture sector will be equal to the intercept term of 2.490840.

The R^2 (0.900841) indicates that 90% of the variations in per capita GRDP in agriculture sector are jointly explained by the explanatory variables, while the remaining 10% are accounted for by variables not included in the model. The probability value of the F-statistic 0.000075 indicates that the entire model is good and reliable.

Infrastructure and Per capita GRDP in Manufacturing Sector

Table 5 below presents the results for infrastructure variables and manufacturing sector. The coefficient of electricity infrastructure is positive and highly statistically significant at 5% level of significant. Hence, a 1 percent point increase in per capita electricity produced will raise per capita GRDP in manufacturing sector by 0.82 percent. Therefore we accept our hypothesis 2 above which states per capita electricity produced has a significant influence on per capita GRDP in manufacturing sector.

Furthermore, the coefficient of water infrastructure also turns out to be highly statistically significant at 5% level of significant. Moreover, the coefficient has a positive sign. This implies that if per capita value of clean water supplied increase by 1 percent point, per capita GRDP in manufacturing sector will increase by 0.28 percent. This supports hypothesis 2 which states that per capita clean water supply has a significant influence on per capita GRDP in manufacturing sector.

The coefficient of paved road per capita also turns out to be positive but empirical evidence shows that this is not statistically significant. There is clear evidence to reject hypothesis 2 which states that per capita kilometer of paved road has a significant influence on per capita GRDP in the manufacturing sector .

Table 4. T-test results for Infrastructure and Manufacturing sector

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.934194	0.967435	1.999302	0.0766**
LnELE	0.823637	0.354294	2.324726	0.0451*
LnWATER	0.275441	0.108029	2.549706	0.0312*
LnPAVE	0.000952	0.026494	-0.035931	0.9721

$R^2 = 0.904861$ Prob. (F-statistic) = 0.000063

*** =significant at 5% level ** = significant at 10% level**

Meanwhile the intercept term has a positive sign. This implies that if all the coefficients are set to 0, the dependent variable will be equal to 1.934194 because the p-value is statistically significant at 10% level of significant.

In general, this study shows that when physical infrastructures are proxied by per capita electricity produced and per capita value of clean water supply, the result shows a statistically significant and positive relationship with per capita GRDP in manufacturing sector. On the other hand, when per capita kilometers of paved road are used as a proxy for physical infrastructure, the result shows insignificant relationship with per capita GRDP in manufacturing sector.

The coefficient of determination R^2 (0.904861) indicates that 90% variations in the dependent variable are explained jointly by the repressors. The remaining 10% are accounted for by the variables not captured in the model. The probability value of the F-statistic of 0.000063 indicates that the entire model is reliable

Infrastructure and Per capita GRDP in Trade Sector

The results for infrastructure and trade sectors are quite similar with those of manufacturing sector. All the coefficients of the infrastructure variables are statistically significant. Electricity infrastructure shows a positive and highly statistically significant relationship with per capita GRDP in trade sector at all levels of significant. The coefficient of 1.285168 implies that if electricity produced changes by 1 percent, per capita GRDP in trade sector will increase by 1.29 percent. Therefore the results supports hypothesis 2 which states that per capita electricity produced has a significant influence on per capita GRDP in trade sector

Table 5. T-test results for Infrastructure and Trade sector

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.427331	0.466378	5.204644	0.0006*
LnELE	1.285168	0.170797	7.524535	0.0000*
LnWATER	0.211216	0.052078	4.055751	0.0029*
LnPAVE	0.002473	0.012772	-0.193651	0.8507

R^2=0.981820 Prob. (F-statistic) = 0.000000

***=1% level of significant**

The water supply infrastructure also turns out to show a positive and statistically significant relationship with GRDP in trade sector at all levels of significant. This proves hypothesis 2 which states that per capita amount of clean water supplied has a significant influence on per capita GRDP in trade sector. Therefore if per capita value of clean water supplied changes by 1 unit, per capita GRDP in trade sector will increase by 0.211216 percent.

The coefficient of per capita paved road is positive but this result is not statistically significant. This does not supports hypothesis 2 which states that per capita kilometers of paved road has a significant influence on per capita GRDP in trade sector.

Meanwhile, the intercept term has a positive sign. This means that if all the coefficients are set to 0, the dependent variable will be equal to 2.427331 because the p-value is statistically significant at all levels of significant.

The R^2 (0.981820) indicates that 98% of the variations in per capita GRDP in trade sector are jointly explained by the explanatory variables, while the remaining 2% are accounted for by variables not included in the model. The probability value of F-statistic of 0.000000 indicates that the entire model is good and reliable.

Discussion of Findings

During the period 2001 to 2013, the accumulation of water supply infrastructure and electricity infrastructure has been significantly contributing to economic growth in South Sumatera Province. This is also true in the agricultural sector, manufacturing sector, and trade sector. The result, in general is consistent with the endogenous growth theory proposed by Barro (1990). That is, provision of public infrastructures directly serves as productive inputs in the production process and this further creates a positive linkage with the economic growth.

The result also confirms the theoretical argument by Li (2009) in the economic literature. His widely-accepted argument is that apart from being a direct input in the production process, infrastructure may also be the source of economies of scale and scope throughout the economy (indirect effect). For example, improvements of the electricity infrastructure may enhance the productive capacity of the firm thus allowing more efficient use of certain types of machineries available, reducing worker's stress, and further contribute to productivity. Moreover, it can increase welfare through multiplier effects not only for the labor but also for the society. It is through this channel that infrastructure can play in promoting growth. Possible channels also include an indirect impact through external effects such as better health and better productivity of workers as claimed by Agénor and Moreno-Dodson (2006).

Furthermore, the findings also supports the work of Deininger and Okidi (2002) on Uganda who shows empirically that access to key public goods, such as electricity and clean water supply, critically determine worker's productivity, enhanced households' ability to increase its income and thus contribute to growth.

In addition, the result of this study is closely related to the empirical findngs by Lewis (1998) on the impact of water supply and road infrastructure on Municipal Economic Development in Kenya. The impact of water supply infrastructure on economic growth measured by GDP per capita is greater than that of road infrastructure. Compare to the result provided by Lewis (1998), the results are quite similar, despite of its varying level of elasticity and the degree of significant. This difference might be because of different measures of infrastructures provided in the area of the study.

Having said the above, one wonders why road infrastructure has the correct sign according to theory, but does not have any significant influence on per capita output. A possible reason for this could lie in the definition of the roads infrastructure variable as kilometers of paved roads. Statistic of Indonesia categorize road into two categories. First, based on surface type (Paved and non Paved) and second, based on road condition (Good, moderate, and bad). In this paper, road infrastructure were measured only by the length of the paved road (kilometers), without considering the quality of the road, it might be possible that quality of road infrastructure will provide higher impact on growth. In other words, roads that are not paved are not accounted for in the analysis, which in turn could lower the correlation between per capita GRDP and roads infrastructure.

In addition, the number of paved road in South Sumatera Province increased from 203,214 km in year 2000 to 277,755 km in year 2010. However, on average, number of paved road surface is only 57%. The growth of road network still cannot reach the growth of motor vehicles. Road development is about 3% each year while vehicle growth is about 9 to 15% (Statistic of Indonesia 2010). Therefore in this sense, it can be generalized that passenger traffic and congestion can also seem to be the main problem that could possibly hinder growth. From the perspective of firms, road infrastructure expected to producing considerable savings in time and money has not been reflected in a change in the pattern of economic activities. The implication is that "people move, and not productive activities". This is consistent with the argument proposed by Plassard's (1991) and Buchan (1985). That is, bad condition of roads and traffic congestion can also seem to be the main problem.

The results also shed light on the recent report published by the Indonesia Provincial Commercial Business Report (2012). That is, in agriculture, South Sumatra is home to some 70% of Indonesia's oil palm plantation area and 65% of natural rubber production, yet productivity is far below the productivity of its neighbors and competitors. This has been blamed on low seed quality and inadequate use of fertilizers but most importantly is the long transport times associated with increased transportation cost. Therefore these factors could also lower the correlation between road infrastructure and per capita output in agriculture sector.

Another point of interest, South Sumatera Province is full of swampy areas and is connected by nine (9) major rivers. Therefore apart from road infrastructure, the ability of key sectors (e.g. agricultures sector) to contribute to growth in South Sumatera Province also depends crucially on railway, water and sea transport. These infrastructures are very important for facilitating linkage to local and international markets. Most of the agricultural commodities are exported to international markets via sea transport. This makes road infrastructure less dominant form of transport and therefore might not have a bigger impact on economic growth.

CONCLUSION

Based on the data analysis and discussion, several conclusions can be made. Firstly, based on the region, partial test showed that electricity infrastructure has a significant influence on per capita GRDP in South Sumatera Province. Its coefficient is positive, which means that any increase in the stock of electricity infrastructure will contribute further to growth. Water supply infrastructure also has a positive and significant effect on economic growth in South Sumatera Province. Elasticity of electricity infrastructure on growth is higher than water supply infrastructure. On the other hand, road infrastructure does not have any significant effect on economic growth in the province.The joint test based on the p-value of F-statistic showed that electricity infrastructure, water supply infrastructure and road infrastructure can jointly influence per capita GRDP in South Sumatera Province.

In the agriculture sector, partial test showed that electricity infrastructure can significantly influence per capita output in the agriculture sector. Water infrastructure also plays a significant role in influencing per capita output in the agriculture sector. On the other hand, road infrastructure does not have any significant effect on per capita GRDP in the agriculture sector. The joint test based on the p-value of F-statistic indicates that the existing stock of physical infrastructures can jointly influence per capita GRDP in the agriculture sector.

In the manufacturing sector, partial test showed that electricity infrastructure and water supply infrastructure both have a significant and positive effect on per capita output in the manufacturing sector. Road infrastructure has a positive sign but this is not significant enough to have any real effect on per capita GRDP in the manufacturing sector. The joint test based on the p-value of F-statistic showed that all three measures of physical infrastructure can jointly affect per capita GRDP in the manufacturing sector.

For the trade sector, the partial test showed consistent result similar to the manufacturing sector. Electricity infrastructure and water supply infrastructure are crucial input and therefore impact significantly in this sector. Meanwhile, road infrastructure has a positive sign but is not significant enough to have any real impact on per capita output in the trade sector. The joint test showed that all three measures of physical infrastructures can jointly affect per capita output in the trade sector.

RECOMMENDATIONS

These results have some important implications for policy in the future. Firstly, if economic growth is a high priority for government intervention, the evidence from this study clearly shows that these objectives can be achieved by focusing more on expanding electricity infrastructure and water supply infrastructure. These two infrastructures are crucial for sustaining the growth of the province as well as enhancing the contribution of manufacturing sector and the trade sector.

Secondly, there are certain internal forces that may potentially inhibit the ability of the road infrastructure to effectively contribute to economic growth, both in the province as well at the sectoral level. For example, traffic congestion. Therefore development effort aimed at addressing this bottle-neck and other constraints may enable this important infrastructure to be the engine of growth.

Limitations of the Study

In any research, there are possible hitches which are inevitable. This research is not an exception. Therefore, in the process of this research, some problems were encountered.

First, empirical studies on the effect of infrastructure development on economic growth involve time series data which has to do with a lot of pre-tests and investigations. This will likely affect the quality of the research work.

Second, the choice of variables selected may not be the appropriate measures of physical infrastructures development in the province under study. This will also likely have an effect on the quality of the research findings.

Lastly, the study deals with secondary data obtained primarily from Badan Pusat Statistic. Therefore if the data contain some measurement errors, this may likely affect the robustness of the findings.

Despite these limitations, the research intends to review as much as is possible the relationship between physical infrastructure development and economic growth and apply an appropriate method of analysis that will suit the data set we are dealing with.

Suggestions for further studies

The result of this paper warrant further studies to be undertaken in the future. As this paper only use electricity, water supply and road infrastructure to measure economic performance, further research is needed to investigate the impact of infrastructure by adding more infrastructure variables and with longer period of data. Furthermore, in this paper I use data of total length of paved road without considering the quality and different conditions of the road, therefore for further research, it might be better if consider on the quality of the road.

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