Infrastructural Financing in Nigeria: Growth Implications

ADESOYE, A. Bolaji (PhD)
Department of Economics, Olabisi Onabnajo University, Ago-Iwoye, Ogun State, boladesoye@yahoo.com

Abstract
This study critically analyzes the effects of infrastructural financing on economic growth in Nigeria between 1970 and 2010. The time frame is selected based on data availability and to cover major structural economic eras in Nigeria since a decade after independence. The empirical model employed for this study is adopted from the work of Cullison (1993) and later modified. The econometric model incorporates components of government infrastructural spending based on functions. The ordinary least square (OLS) method is used to estimate the empirical model. The result of analysis revealed that that government community service infrastructure spending, private infrastructure investment, broad money supply, and total population, exert positive influence on economic growth. While, government economic service infrastructural spending and total domestic and external debt exerts negative effects on economic growth in Nigeria. On the basis of the significant F-statistic result the null hypothesis "infrastructural investment has significant effect on economic growth in Nigeria". Policy recommendations are proffered based on the empirical findings.
Keywords: Infrastructure Financing, Public Investment, Public Private Partnership (PPP), Economic Growth, Nigeria

I. Introduction

It has long been recognized that adequate supply of infrastructure services is an essential ingredient for productivity and growth in any economy. In recent years, the role of infrastructure services have received increased attention. Much of the current international debate on ways to spur growth, reduce poverty, and improve the quality of human life in low-income developing countries has been centered on the need to promote large increase in public investments in infrastructure. Report by the United Nations Millennium Project (2005), the Blair Commission (2005) and the World bank (2005) have dwelt on the importance of a "Big Push" in public investments in core infrastructure, financed by generous debt relief and a substantial increases in foreign aids (Agenor and Moreno-Dodson, 2006).

Infrastructure has become a ubiquitous theme in a variety of areas of the policy debate. For instance, there is persuasive evidence that adequate provision of infrastructural facilities is a key element in the agenda required for an economy to achieve its intended objectives of efficient resources allocation and growth. Also, a number of studies (Adesoye, Maku and Atanda, 2010; Agenor and Moreno-Dodson, 2006) have argued that generalized access to infrastructure services plays a key role in helping reduce income inequality (World Bank, 2003).

There is general view that public infrastructure expenditure, either recurrent or capital expenditure, notably on social and economic infrastructure like transportation and communication can be growth-enhancing, although the financing of such expenditure to provide essential infrastructural facilities-including transport, electricity, telecommunications, water and sanitation, waste disposal, defense, education and health-can be growth-retarding (for example, the negative effect associated with taxation and excessive debt) (Adesoye, Maku and Atanda, 2010).

A common argument for a large increase in public spending on infrastructure is that infrastructure services may have a strong growth-promoting effect through their impact on the productivity of private inputs and the rate of return on capital— particularly. To begin with, stocks of infrastructure assets which are relatively low. In that regard, low-income countries like Nigeria are at a particular disadvantage. In Sub-Saharan Africa for instance, only 16 percent of roads are paved, and less than one in five Africans has access to electricity. The average waiting time for a fixed telephone connection is three and a half years. Transport costs are the highest of any region (Agenor and Morenor-Dodson, 2006).

Against this background, there is a growing perception that in many countries the pressures of fiscal consolidation have led to a reduction in public infrastructure spending, which has not been offset by the increase in private sector participation, thus resulting in an insufficient provision of infrastructure services with potentially adverse effects on growth and inequality. It is also evidenced that in Sub-Sahara Africa (SSA) only 16 percents of roads are paved, and less than one in five African have access to electricity. The average awaiting time for a fixed telephone connection in three and a half years (Agenor and Moreno-Dodson, 2006). The interest of this study stems from the immense contribution of infrastructure on growth in order to identify the real impact of public infrastructure spending on economic growth in Nigeria. In spite of the ever increasing government infrastructural spending in Nigeria, there is still inadequate infrastructures facilities in the country such as electricity, roads among others reveals that either the expenditure are not properly channeled for infrastructure

provisions and this area is neglected by the policy makers for adequate attention. This in particular is what this study is interested in examining critically and empirically.

The provision of public infrastructure services in the country to meet the demands of the various economic agents in the face of the ever increasing population of the country has been a major problem in the country. The increasing rate of unemployment alongside increasing price level, the consequential increase in insecurity and crime rate, hence the true nature of the infrastructural provision needed to be investigated vis-a-vis the growth pattern of the country.

In recent times, diverse opinions exist as to the efficiency of public expenditure on public infrastructures positively or negatively. There have been a great number of studies using national and international data as to empirically investigate the impact of infrastructural provisions on economic growth.

Furthermore, the ever increasing rate of government spending annually with special reference to infrastructure growth in Nigeria cannot be compared. The poor state of infrastructures- good roads, electricity etc as compared to the huge amount committed to providing these infrastructures also motivate this study.

Finally, in line with the current development policy vision 20:2020 of the federal government of Nigeria, the role of infrastructural adequacy is given focal attention, this study is a welcome effort towards assessing how far the economy can go in making use of its huge amount of public expenditure in providing the infrastructures needed for growth to become one of the leading world economies.

Therefore, on the basis of the above identified issues and motivation for this study, the main thrust of this paper is to examine the effect of infrastructural spending on economic growth in Nigeria between 1970 and 2010. The remaining sections of this paper are divided into five sections. Section two discusses literature review and theoretical foundation. Section three covers model specification and estimation technique. Section four provides estimated results plus discussion of findings, while the last section concludes and proffers policy outlooks.

II. Literature Review

Infrastructure has been proved to be of significant effect in economic take-off and long-run growth worldwide. Generally speaking, infrastructure includes permanent sets of engineering construction, equipment, and machinery and the service they provide to production and household consumption. Infrastructure can be divided as economic and social ones, the former refers to the public utilities such as electricity, telecommunications, water supply, sanitary and drainage, public engineering construction such as dam and irritation system, and the transport facilities such as railway road, harbor and airport; while the latter refers to education, medicare and health services (World Bank, 1999; Zhang, et al, 2007).

Empirical studies at international level using cross sectional, time series and panel data sets has assisted in econometric investigations that allows for important comparison in previous studies. Aschauer (1989), studied the economic contribution of public investment, of which transport capital forms part for the G7 countries using panel data for the period 1966-1985. He specified a Cobb-Douglas function and came out with an output elasticity of 0.34 to 0.73 which clearly shows the importance of public investment in productivity and growth. In a subsequent study, Aschauer (1995) also used a total productivity growth function with fixed country and time effects to study the similar effect for 12 OECD countries over the period 1960-1988. He reported a contribution between 33 – 55% of the non-military public capital stock to output growth.

Nourzad and Vrieze (1995) also studied a panel data for 7 OECD countries over the period 1963-88 on the effect public investment on output. Using similar econometric specification as Aschauer(1989) but controlling for energy input price and taking into account random effects, they found a relatively low but significant output elasticity of 0.05 with respect to public investment. In a recent study Canning (1999) estimated an aggregate production function for a panel set of 77 countries. He used annual cross country data for the period 1960-1990 and his production function (a Cobb-Douglas function) incorporated labour, physical capital, human capital and infrastructure variables (number of telephones, electricity generally capacity and kilometres of transportation routes). His approach included panel data co-integration methods, which took account of non-stationary nature of data and are also robust to reverse causation. Canning found that the elasticity of output with respect to physical capital is around 0.37. However he observed no significant impact of elasticity generating capacity, or transportation structure on growth. But since these types of infrastructure capital have already been included in his physical capital stock, the implication was that that they had the normal growth effect of capital as a whole, thus justifying their importance.

In another study, Canning and Bennathan (2000) built on the above data set (they extended the sample to 89 countries) and methodology to analyse the hypothesis. The other important difference as compared to Canning's (1999) study was that they also estimated a translog specification which allows for flexibility in the

elasticity of substitution between factors and also flexibility in the pattern of rates of returns across countries. The authors reported, in the Cobb Douglas case, positive rates of return for the case of paved roads (0.048-0.083). When adding both together they retain their positive coefficient and were statistically significant. Results from the trans-log function show that both kinds of infrastructure were necessary but not sufficient by themselves to trigger large changes in output. The study also revealed that infrastructure is more productive with higher levels of physical and human capital.

However it is important to also note that other studies at international level have proved the insignificance and mixed results of public investment on productivity and output growth. For instance, Ford and Poret (2005), using data on non-military public capital stock, and also including privately provided infrastructure services as well, for 11 OECD countries over the period 1960-1988 found that his broad definition of infrastructure (including structures in electricity, gas and water and structures in transport and communication) had significant effect on productivity and output for 5 of the 12 countries, namely, US, Germany, Canada, Belgium and Sweden. He used a total factor productivity growth and Autoregressive of order 1 and 2 models for his estimations.

Other research reports on the importance of infrastructure on economic development have been overemphasized. For instance Neuser (1993), using public capital data from Ford and Poret (2005) for the G7 countries over the period 1970- 87, applied Total factor productivity growth and co-integration techniques to the sample. They reported insignificant and unstable results. Taylor-Lewis (1993), using the same data set for the same countries under observation, but regressing a Cobb-Douglas function found that the contribution of public physical infrastructure to output were insignificant.

Summarily, the major empirics of infrastructure and economic growth can be presented in a tabular form in the appendix. It is observed that existing literature has been exclusively concentrated on time series and panel data sets of developed countries cases. Moreover most of these studies dealt with the estimation of the output effect from public capital in general. The novelty of the study is that it attempts to analyse the contribution of one component of public capital, transport capital, on the growth of the Nigerian economy.

III. Theoretical Framework and Methodology

3.1 Theoretical Consideration

The theoretical foundations in the explanation of the effect of infrastructure on growth and development outcomes are mostly encountered in growth theories, (for example, standard growth theory references are the works of Aghon and Howitt, 1988, and Barro and Sala-i-Martin, 2004), and the new economic geography literature. Agenor (2004) and Agenor and Moreno-Dodson (2006) discuss and model several channels through which infrastructure may affect growth. However, this study as discussed by Straub (2008) focused on the growth theory and economic geography theories.

Firstly, a number of theoretical justifications for advocating policies fostering investment in infrastructure are found in the growth literature. Most of the channels discussed in this context are represented in a generic framework based on an aggregate production function. The reason is that it allows for a different way to incorporate infrastructure in the production function. and in the last decades a growing part of infrastructure investment has been mediated through the market and has taken characteristics of standard private goods. Second, even when private operators are involved, the level of unit costs and prices of infrastructure services are often not strictly market determined, so including a factor in the production function would rely on the unrealistic assumption that firms are able to make informed decisions on the cost of the amount of infrastructure capital they use (Duggal, Saltzman and Klein, 1999)

The direct channels from infrastructure capital, whether in its pure public good or intermediate inputs form, to growth first involve a simple productivity effect. Indeed, in a standard production function with factors being gross complements, an increase in the stock of infrastructure would raise the productivity of the other factors. An extreme version of the direct effect of infrastructure corresponds to the case of strong complementarities. For example, by providing access to certain remote or un-communicated areas, roads or bridges make private investment possible. Similarly, by giving entrepreneurs access to certain services such as electricity or telecommunications, investments in critical parts of infrastructure networks enable corresponding private investment. Note, however, that the way infrastructure investments are financed is obviously not neutral and that the risk of a crowding-out effect on private investment exists, especially if these investments are financed through taxation or borrowing on domestic financial markets (Straub, 2008).

Another relevant theory of consideration is the economic geography theory. One striking feature of the economic geography theory in the explanation of infrastructure is focus on the geographical aspect of its illustration. One fact about earlier explanations is the fact that they completely overlook one of infrastructure's main feature – its geographical dimension. Indeed, it is fairly obvious that infrastructure investment is by nature spatial, since it involves rival choices on the location of equipments that will serve limited geographical areas.

This is true for example of roads, bridges, canals, airports and railroads for transport, pipes and sewerage networks for water and waste water treatment, base towers for telecommunication services, electricity or gas networks and connections for energy (Straub, 2008).

In addition, infrastructure services are an input in both households' and firms' consumption and investment decisions. Variations in the availability and quality of infrastructure across space will therefore result in different economic agents' behavior depending on their location. Moreover, they will also crucially influence agents' location decisions, such as migration, establishment of new firms, investment of capital at different locations, etc.

The theoretical foundations in the explanation of the effect of infrastructure on growth and development outcomes are mostly encountered in growth theories, (for example, standard growth theory references are the works of Aghon and Howitt, 1988, and Barro and Sala-i-Martin, 2004), and the new economic geography literature. Agenor (2004) and Agenor and Moreno-Dodson (2006) discuss and model several channels through which infrastructure may affect growth. However, this study as discussed by Straub (2008) focused on the growth theory and economic geography theories.

3.2 Model Specification

The econometric model employed by Cullison (1993) to analyze the inter-relationship between public investment and economic growth in selected developing countries is adopted for this study. Cullison (1993) empirical model is formulated on government spending by functions and augmented with the integration of exogenous factors like broad money supply, real public defense spending, and government debt. However, the adopted Cullison (1993) econometric model is express as:

$$RGDP_t = \alpha_0 + \alpha_1 GSF + \alpha_2 X + u \qquad (3.1)$$

Where RGDP = Real gross domestic product; GSF = Government Spending by Function (considered 21 active sectors in the economy); X = set of exogenous factors; α_0 = Intercept or constant; α_{1-2} = Parameters or Co-efficient of explanatory variables; u = Error term;

However, the Cullison (1993) model is modified taking into consideration of single country scenario in the empirical analysis and the structure of the Nigerian economy in relation to demand, supply and pattern of infrastructural finance. Based on non-availability of wide disaggregated data on government spending by function and private gross domestic product, the model incorporates government infrastructure spending on economic services, social and community services and private investment. Also, government spending on defense is excluded from the empirical model considering its non-relevance and the major focus of this study. Although, level of total population is incorporated as one of the exogenous factors of interest since demand for infrastructure facilities in developing countries is mostly facilitated by increase in total population level. Therefore, the empirical model for this study is specified as:

$$RGDP_t = \alpha_0 + \alpha_1 GES + \alpha_2 GCS + \alpha_3 PIN + \alpha_4 DBT + \alpha_5 MS + \alpha_6 POP + u \qquad (2)$$

Where: GES = Government infrastructural spending on economic services; GCS = Government infrastructural spending on social and community services; PIN = Private Investment; DBT = Government total debt; MS = Broad money supply; POP = Total population level; α_0 = Intercept or constant; α_{1-5} = Parameters or Co-efficient of explanatory variables.

From the specified model (2), the incorporated variables in the modified Cullison (1993) model are expected to enhance economic growth positively excluding government debt which bi-causal in effects. If government debt is infrastructural investment oriented it will enhance real output, otherwise. This can be expressed symbolically as follows:

$$\frac{\partial RGDP}{\partial GES} > 0;\ \frac{\partial RGDP}{\partial GCS} > 0;\ \frac{\partial RGDP}{\partial DBT} > 0;\ \frac{\partial RGDP}{\partial MS} > 0; \text{ and } \frac{\partial RGDP}{\partial POP} > 0;$$

3.3 Estimation Techniques

In estimating the specified multiple regression model the unrestricted Classical Least Square (CLS) is used. The estimated parameters are subjected to evaluation by using the student t-statistic test and F-statistic test. While, the overall stability of the specified empirical model is tested using multiple co-efficient of determination (R^2), adjusted R^2 and Durbin-Watson test.

3.4 Sources of Data

Based on the nature of incorporated variables in the formulated model, secondary data is employed for detail analysis. The time series data are sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin, Volume 21, 2010 and World Development Indicator (April, 2011).

IV. Empirical Results

4.1 Introduction

The data and methodological description for the econometric analysis of the impact of public infrastructural investment on economic growth in Nigeria between a decade after independence (1970) and 2010 are covered in this section of the study. The time frame for the analysis is chosen based on availability of data from various sources. Also this study captured the effect of several economic eras that the economy has undergone since independence in the analysis. This ranges from the period of Pre-Structural Adjustment Programme (SAP), Structural Adjustment Programme (SAP) and Post-Structural Adjustment Programme (SAP).

The data sourced for the analysis of this study are presented in the appendix and employed to estimate the multiple regression model specified in the previous section using the E-Views version 7.0.

4.2 Results and Discussion

The estimated result for the multiple parameters regression specified to capture the the impact of infrastructural financing on economic growth in Nigeria between a decade after independence (1970) and 2010 is presented in table 4.1

Table 4.1: Estimated Regression Results

Dependent Variable: RGDP				
Method: Least Squares				
Sample: 1970 2010				
Included observations: 41				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-360146.9	41420.47	-8.694901	0.0000
GES	-0.377483	0.118762	-3.178491	0.0032
GCS	0.165016	0.646333	0.255311	0.8001
PIN	0.099620	0.135893	0.733074	0.4687
DEBT	-0.003848	0.005701	-0.674906	0.5044
MS	0.025573	0.007906	3.234410	0.0028
POP	0.006189	0.000523	11.83824	0.0000
R-squared	0.971035	**S.D. dependent var**		200137.4
Adjusted R-squared	0.965768	**F-statistic**		184.3830
Durbin-Watson stat	1.087177	**Prob(F-statistic)**		0.000000

Source: Extracted from the result appendix

The estimated result for the multiple parameters regression specified to capture the effect of infrastructural financing on economic growth in Nigeria between 1970 and 2009 presented in table 4.1 revealed the effect of incorporated factors for the econometric analysis of the study. The table 4.1 reports that government community service infrastructure spending (GCS), private infrastructure investment (PIN), broad money supply (MS) and total population (POP) exert positive influence on economic growth in Nigeria between a decade period after Nigeria's independence and 2009 fiscal year and all of the effects conform with the theoretical expectation. This implies that for a unit increase in government community service infrastructure spending

(GCS), private infrastructure investment (PIN), broad money supply (MS) and total population (POP), the Nigerian real gross domestic product (RGDP) will increase by units 0.1650, 0.0996, 0.0256, and 0.0062 respectively. The table 4.1 also reports that the government economic service infrastructural spending (GES) and total domestic and external debt (DEBT) are found to exerts negative effects on economic growth in Nigeria during the review periods and these does not conform with the apriori expectations based on sign. This implies that the government spending in the provision of Agriculture, Construction, Transportation and Communication as well as total domestic and external debts was growth retarding during the reviewed period. However, in terms of magnitude of effect, a unit increases in government economic service infrastructural spending (GES) and total domestic and external debt (DEBT) will deteriorates the gross domestic products by 0.3775 and 0.00385 units.

In assessing the partial significance of the estimated parameters for the considered variables, the t-statistics results are presented in the table 4.1. The result shows that the estimated parameters for government economic service infrastructural spending (GES), broad money supply (MS) and population level (POP) were found to be partially statistically significant at 5% critical level because their p-values are less than 0.05. While, the estimated parameters for government social and community service infrastructural spending (GCS), private infrastructural investment (PIN), and total debt (DEBT) were found insignificant at both 5% and 10% critical level.

Although, the F-statistic result shows that all the incorporated infrastructure investment, monetary and demographic indicators are simultaneously significant at 5% critical level. While, the adjusted R-squared result reveals that 97% of the total variation in economic output growth is accounted by changes in government economic service infrastructural spending (GCS), government social and community service infrastructural spending (GCS), private infrastructural investment (PIN), total debt (DEBT), broad money supply (MS) and population level (POP) during the review period. The Durbin- Watson test result reveals that there is presence of positive serial correlation among the residuals, because of the d-value (1.08718) is close to two.

4.3 Policy Implications

The econometric analysis of the effect of infrastructural investment on economic growth in Nigeria between 1970 and 2010 following the empirical work of Cullion (1993) explored the overview of the growth effects of investment structure in the provision of infrastructural facilities. From the empirical analysis, it is deduced that government investment in the health and education sectors have been inadequate to propel economic growth as a result of low budgetary allocation and this therefore reflect the high depth of neglect of these sectors in relative to others and this tends to call for immediate attention via Public Private Infrastructural Investment (PPII) scheme. Also, the negative growth effect of external and domestic debts on growth for infrastructural provisions indicates that this form of infrastructural investment financing option has serious welfare and growth implications on future strategic plans due to transfer of high interest payments to future generation and tends to hamper Nigerian output growth and deteriorate future maintenance of present infrastructure facilities.

5.0 Conclusion and Policy Recommendations

5.1 Conclusion

The analysis of the effect of infrastructural financing on economic growth in Nigeria between 1970 and 2010 that span across the period of Pre-Structural Adjustment Programme (SAP), Structural Adjustment Programme (SAP), Post-Structural Adjustment Programme (SAP) and also the present era of National Economic Empowerment Development Strategy (NEEDS) revealed that government economic service infrastructural spending (GES), broad money supply (MS) and population level (POP) are significant factors influencing the growth rate of Nigerian economy.

Therefore, based on the F-statistic result this study rejects the null hypotheses and concludes that infrastructural financing by the public and private sectors have significant effect on the Nigerian economy during the reviewed period.

5.2 Recommendations

On the basis of the empirical findings for the effect of infrastructure financing on economic growth in Nigeria during the periods of Pre-Structural Adjustment Programme (SAP), Structural Adjustment Programme

(SAP) and Post-Structural Adjustment Programme (SAP) and National Economic Empowerment Development Strategy (NEEDS) eras, the following strategic policy options are proffered as follows:

I. The government should effectively regulate the budgetary allocation for infrastructural spending in order to foster real sustainable growth;

II. The government should reduce the rate of domestic and external debts meant for infrastructural projects but often used for other non-infrastructure investments;

III. Proper population management strategy should be instituted in order to maintain population growth with respect to availability of infrastructure facilities. This will further enhance the productive level of the growing population in Nigeria;

IV. Likewise, the monetary authority should maintain their monetary stance and liquidity level from time to time. This to ensure that there is abundant availability of fund in the economy to take up new capital intensive;

V. Policies on transparency and accountability should be instituted in order to curb the menace of self-centeredness, greed, corruption and public funds mismanagement among Nigerian leaders in order to earn the immense growth benefits from infrastructural investment; and

VI. The public sector should endavour to finance more high capital intensive infrastructural investments in order to make their growth contributions significant.

REFERENCES

Adesoye, A. B, Maku E. O, and A. A. Atanda (2010): Dynamic Analysis of Government Spending and Economic Growth in Nigeria. Journal of Management and Society, Vol. 1, No 2, pp. 27-37, December Edition 2010 Available Online at http://www.lautechtransportmgt.com/journal.html

Agénor P.R. (2004), The Economics of Adjustment and Growth, 2nd ed., Harvard University Press.

Agénor P.-R. and B. Moreno-Dodson (2006), "Public Infrastructure and Growth: New Channels and Policy Implications", World Bank Policy Research Working Paper 4064.

Agénor, P, and D Yilmaz, (2006) "The Tyranny of Rules: Fiscal Discipline, Productive Spending, and Growth," Working Paper No. 73, Centre for Growth and Business Cycle Research. July.

Aghion P. and P. Howitt (1998), Endogenous Growth Theory, MIT Press, Cambridge, MA.

Albala-Bertrand, José M., and Emmanuel C. Mamatzakis, (2004) "The Impact of Public Infrastructure on the Productivity of the Chilean Economy," Review of Development Economics, 8 (June), 266-78.

Aschauer, David A., 1989. Is public expenditure productive? Journal of Monetary Economics 23, 177-200.

Barerjee, A., Duflo, E., and Qian, N. (2009) On the Road: Access to Transportation Infrastructure and Economic Growth in China. Preliminary Version, March. Accessed from www.google.com. May 2011.

Barro, Robert J., and Xavier Sala-i-Martin (1995) Economic Growth, (New York: McGraw-Hill)

Berndt E.R., and B. Hansson, 1992. Measuring the contribution of public infrastructure capital in Sweden. The Scandinavian Journal of Economics 94 (Supplement), 151-168.

Canning, D. (1999), 'Infrastructure's contribution to aggregate output,' World Bank Policy Research Working Paper, No. 2246, Washington, D.C.

Canning, D. and E. Bennathan, 2000. The social rate of return on infrastructure investments. Policy Research Working Paper Series 2390. Washington DC: World Bank.

Cohen J. and C. Morrison Paul, 2004, "Public Infrastructure Investments, Interstate Spatial Spillovers, and Manufacturing Costs", Review of Economics and Statistics.

Cottam, H., 2007, 'A concrete response to poverty? Rethinking approaches to urban poverty and infrastructure. A Zambian case study', IDS Bulletin, Vol 28 No 2, Brighton: IDS

Cullison, W. E. (1993). Public Investment and Economic Growth. Federal Reserves of Richmond Economic Quarterly, Volume 79/4 Fall.

Demetriades, P O., and T P. Mamuneas (1998) 'Intertemporal Output and Employment Effects of Public Capital: Evidence from 12 OECD Economies,' paper presented at the 52nd Econometric Society European Meeting (Toulouse, 2007)

Demurger, S (2001) "Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China?" Journal of Comparative Economics, 29, pp. 95-117.

Easterly, W. and S. Rebelo, (1993). Fiscal policy and economic growth: An empirical investigation. Journal of Monetary Economics 32, 417-458

Ford, Robert and Pierre Poret, (2005). Infrastructure and private sector performance. OECD Economic Studies 17, 63-89.

Foster A. D. and M. R. Rosenzweig (2003) "Agricultural Productivity Growth, Rural Economic Diversity and Economic Reforms: India, 1970 - 2000" presented at D, Gale Johnson Memorial Conference. October.

Fox, W., 1994, 'Strategic options for urban infrastructure management', Urban Management Programme Policy Paper 17, Washington D.C.: World Bank

Gordon, R.J. (2008): "Has the "new economy" rendered the productivity slowdown obsolete?" June, Northwestern University, mimeo.

Hulten, C. R. and R. M. Schwab, (2005). Public capital formation and the growth of regional manufacturing industries. National Tax Journal XLIV, 121-134.

Ireland, P. N. (1994) "Supply-side Economics and Endogenous Growth", Journal of Monetary Economics, 33, June, 559-71.

Jaffe, A., M. Tratjenberg and V. Henderson (1993), 'Geographic Location of Knowledge Spillover as Evidenced by Patent Citations,' Quarterly Journal of Economics, 108, 577-598.

Levy, C., (2005), 'Gender and third world development. Module 5: towards gender-aware provision of urban transport', Brighton: IDS

Mitsui, H. (2004), "Impact Assessment of Large Scale Transport infrastructure in Northen Vietnam", unpublished, World Bank, May

Munnell, A.H., (1990). How does public infrastructure affect regional economic performance? New England Economic Review 9, 11-32

Nourzad F and Martin Vrieze (1995), ' Public Capital Formation and Economic Growth: Some International Evidence.' Journal of Productivity Analysis, Vol. 6, No. 4, 283-295

Pereira, A.M. and R.F. De Frutos (1999), 'Public capital accumulation and private sector performance,' Journal of Urban economics, Vol.46, pp300-322

Puga Diego, 2001, "European Regional Policies in Light of Recent Location Theories", Journal of Economic Geography.

Reinikka Eitva and Jakob Svensson, (2002), "Coping with Poor Public Capital", Journal of Development Economics, 2002, vol. 69 (1): 51-69.

Sida, 2008, Promoting Sustainable Livelihoods, Stockholm: Swedish International Co-operation Development Agency

Singh, K., Steinberg, F. and von Einsiedel, N. (eds), 2008, Integrated Urban Infrastructure Development in Asia, London: Intermediate Technology Publications

Straub, S. (2008) Infrastructure and Growth in Developing Countries: Recent Advances and research Challenges. World Bank Policy Research Working Paper 4460. January.

Tatom, J. A., (1993). Is an infrastructure crisis lowering the nation's productivity? Federal Reserve Bank of St. Louis Review No l. Dec, 3-21. http://ideas.repec.org/a/fip/fedlrv/y1993inovp3-21.html.

Taylor-Lewis, R. (1993), 'The Role of Infrastructure in Productivity and Output Growth: A Case Study of the Group of Seven', Unpublished Ph.D. Dissertation. College Park, MD: University of Maryland, 1993

Teruel Romero, and Yoshimi Kuroda, (2005) "Public Infrastructure and Productivity Growth in Philippine Agriculture, 1974-2000", Journal of Asian Economics, 16 (June), 555-76.

World Bank (2005): Infrastructure for Development World Development Report, Oxford University Press.

World Bank, (1999). Transport in China: An evaluation of World Bank Assistance Report No. 18865. Washington, D.C.: World Bank.

Zhang, J. and Y. Gao, 2007. Why China possesses such good infrastructure? China Economic Review 3, 4-19.

Zou, Z., F. Zhang, Z. Zhuang and H. Song (2008) 'Transport Infrastructure, Growth and Poverty Alleviation: Empirical Analysis of China'. Annals of Economic Finance Vol 9 No 2: 345-371.

APPENDIX
Summary of Empirical Review

Authors	Samples	Estimation Method	Main Results
Aschauer (1989)	Time Series Data of US in 1949-1985	OLS, including time variables	The output elasticity of non-military government spending is 39%, in which the investment on core infrastructure such as highway, electricity supply and telecommunications has a contribution share of 24%
Munnell (1990)	Panel Data of 48 states in the US in 1970-1986	OLS, excluding time variables	Cobb-Douglas function: the output elasticity of highway is 6%, while for other public capital, the elasticity is 12%.
Ford and Poret (2005)	OECD; cross sectional data	OLS	The average elasticity of infrastructure to total factor productivity (TFP) is 45%
Hulten & Schwab (2005)	Time series data of the manufacturers in the US in 1951-1978	OLS	The growth of TFP is the main source of growth. Public expenditure, labour input and capital acculumulation determine the difference of growth across states.
Berndt & Hansson (1992)	Time series data of Sweden in 1960 – 1988	OLS, GLS	The increase in public infrastructure investment can result in decrease in cost of production and increase in profit, the contribution elasticity is 28.9%
Easterly & Rebelo (2003)	Cross-sectional data of 1970-1988; time series data of 28 countries in 1970-1988	OLS, IV	Transport and communication investment contributes positively to growth and the correlation coefficient is between 0.59-0.66. while the co-efficient of general public investment and growth is around 0.4
Tatom (1993)	Time series data of the US in 1949-2005	Granger test	The decrease in public investment in infrastructure results in decrease in productivity, and not vice versa.
Pereira (2000)	Time series data of US in 1956-2007	Pulse Reaction	Among core infrastructure, the investment return of electricity and transport is the highest, 16.1% and 9.7% respectively; both are higher than that of education and medicare.
Demetriades & Mamuneas (2000)	Panek data of manufacture sectors in 12 OECD countries in 1972-2005	OLS	The short run returns of public infrastructure are between 10-20%; for longer period, the return is between 11-25%, in the very long-run, the return os between 16-36%
Demurger (2001)	Panel data of 24 provinces in china 1985-1998	FE, RE, 2SLS	Transport and communication contribute the most to growth, second education.

Source: Adapted from Zou et. al. (2008)

Results

Dependent Variable: RGDP
Method: Least Squares
Date: 11/03/12 Time: 06:28
Sample: 1970 2010
Included observations: 41

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-360146.9	41420.47	-8.694901	0.0000
GES	-0.377483	0.118762	-3.178491	0.0032
GCS	0.165016	0.646333	0.255311	0.8001
PIN	0.099620	0.135893	0.733074	0.4687
DEBT	-0.003848	0.005701	-0.674906	0.5044
MS	0.025573	0.007906	3.234410	0.0028
POP	0.006189	0.000523	11.83824	0.0000

R-squared	0.971035	Mean dependent var	255414.0
Adjusted R-squared	0.965768	S.D. dependent var	200137.4
S.E. of regression	37029.00	Akaike info criterion	24.03442
Sum squared resid	4.52E+10	Schwarz criterion	24.32997
Log likelihood	-473.6884	Hannan-Quinn criter.	24.14128
F-statistic	184.3830	Durbin-Watson stat	1.087177
Prob(F-statistic)	0.000000		