The infrastructure investment effects on GDP growth have been of interest to economists and policy makers in the past 20 years. Around thirty studies have investigated the effect of infrastructure investment on the growth of GDP, resulting in 346 point estimates of the effect. Meta-regression analysis is used to combine these disparate estimates. On average, infrastructure investment exerts positive effects on GDP growth. However, this result is conditional upon the explanatory variables in the different models, which are sources of pronounced heterogeneity in this literature. The main findings are that: a) in this literature there is evidence of Type I publication bias (directional, in this case positive), b) there is also evidence of Type II publication bias (favouring statistical significance regardless of direction) and c) the two types of publication bias are combined with an absence of authentic empirical effect in this literature. For the practice of MRA we make a case for checking the robustness of the results with respect to the estimation technique, model specification and sample.

Dushko Josheski

Dushko Josheski was born on 29 August 1983 in Bitola,Macedonia. He was awarded Msc in Economics for Business Analysis at Staffordshire University, UK with Merit in 2008. Dushko Received first prize in Annual competition for Young Researchers in the field of Macroeconomics organized by the National bank of Republic of Macedonia.

978-3-8454-1511-6

Meta-Regression Analysis

Dushko Josheski

Dushko Josheski

Infrastructure Investment and GDP growth

A Meta-Regression Analysis

LAP LAMBERT Academic Publishing

Dushko Josheski

Infrastructure Investment and GDP growth

Dushko Josheski

Infrastructure Investment and GDP growth

A Meta-Regression Analysis

LAP LAMBERT Academic Publishing

Impressum/Imprint (nur für Deutschland/only for Germany)
Bibliografische Information der Deutschen Nationalbibliothek: Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.

Coverbild: www.ingimage.com

Verlag: LAP LAMBERT Academic Publishing GmbH & Co. KG
Dudweiler Landstr. 99, 66123 Saarbrücken, Deutschland
Telefon +49 681 3720-310, Telefax +49 681 3720-3109
Email: info@lap-publishing.com

Approved by: Staffordshire University

Herstellung in Deutschland:
Schaltungsdienst Lange o.H.G., Berlin
Books on Demand GmbH, Norderstedt
Reha GmbH, Saarbrücken
Amazon Distribution GmbH, Leipzig
ISBN: 978-3-8454-1511-6

Imprint (only for USA, GB)
Bibliographic information published by the Deutsche Nationalbibliothek: The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

Cover image: www.ingimage.com

Publisher: LAP LAMBERT Academic Publishing GmbH & Co. KG
Dudweiler Landstr. 99, 66123 Saarbrücken, Germany
Phone +49 681 3720-310, Fax +49 681 3720-3109
Email: info@lap-publishing.com

Printed in the U.S.A.
Printed in the U.K. by (see last page)
ISBN: 978-3-8454-1511-6

Staffordshire UNIVERSITY

Faculty of business and law

Infrastructure investment and GDP growth: a Meta-Regression Analysis

Author:

Josheski Dushko

September, 2008

Abstract

The infrastructure investment effects on GDP growth have been of interest to economists and policy makers in the past 20 years. Around thirty studies have investigated the effect of infrastructure investment on the growth of GDP, resulting in 346 point estimates of the effect. Meta-regression analysis is used to combine these disparate estimates. On average, infrastructure investment exerts positive effects on GDP growth. However, this result is conditional upon the explanatory variables in the different models, which are sources of pronounced heterogeneity in this literature. The main findings are that: a) in this literature there is evidence of Type I publication bias (directional, in this case positive), b) there is also evidence of Type II publication bias (favouring statistical significance regardless of direction) and c) the two types of publication bias are combined with an absence of authentic empirical effect in this literature. For the practice of MRA we make a case for checking the robustness of the results with respect to the estimation technique, model specification and sample.

JEL Classification Number: H54 - Infrastructures; Other Public Investment and Capital Stock

Keywords: Infrastructure, GDP growth, Meta-Regression Analysis, Publication bias, Sources of heterogeneity.

Table of contents

Chapter 2

Chapter 3

Chapter 4

Chapter 1

"Is there a some action that government of India could take that would lead the Indian economy to grow like Indonesia's or Egypt's? If so, what, exactly? If, not, what is about the "nature of India" that makes it so? The consequences for human welfare involved in question like these are simply staggering: Once one starts to think about them, it is hard to think about anything else" (Lukas, 1988) cited in Barro, Salla I Martin (1995).

1. Introduction

The purpose of this dissertation is to investigate the existing literature and studies about infrastructure investment and growth of GDP. This is done by applying Meta- regression analysis to a set of thirty papers. In the literature, although there are many possible definitions of infrastructure capital [(1)], the definition that makes the most sense from an economics standpoint in that of large capital intensive natural monopolies, such as highways, other transportation facilities, sewer lines and communication systems (Gramlich, 1994).Those can also be called "public goods" which simultaneously provide benefits to more than one individual (non-rivalry in consumption), (Robson, 2007). In essence therefore, infrastructure consists of two elements – "*capitalness*" and "*publicness*" (Fourie, 2006).

1.1 Economic and social infrastructure

Both, economist and urban planners distinguish between (economic) or hard infrastructure and social or (soft) infrastructure. Social infrastructure is the one that promotes health, education, and cultural standards, that have both a direct and indirect impact on the quality life (Fourie, 2006).

[1] Perhaps, sufficiently succinct definition of infrastructure, also called "social overhead" capital, is provided by Hirschman (1958) who defines infrastructure as "capital that provides public services"

1.2 Infrastructure as public goods

The basic premise of public good theory is that the market will not produce enough of public goods to maximize the social welfare, because the benefits of public goods are not limited to a single customer. Although some infrastructure goods are defined as public goods (e.g. highways), most of them are not. Pure public goods are non-rival and non-excludable. A rival good entails that if one good is consumed, the same good cannot be consumed by anyone else. An excludable good is defined as a good that can be excluded from use by a consumer if the price is not paid (Fourie, 2006). Some infrastructure is excludable (e.g. Toll roads).Private toll roads are an alternative to public free-access infrastructure. Most of them are owned privately or by government. Some, owned by the government are privately operated (Palma, Lindsey, 2000).

1.3 Infrastructure with externalities

Some infrastructure goods can also be defined as merit goods. A Merit good is one that can be provided by the market but is regarded as adding an additional value – an external benefit (2) and is provided via the national budget.

1.4 Share of public, private, and total investment to total GDP

Most of these systems are owned publicly (public capital) but some of them are owned privately. Infrastructure "*publicness*" characteristic implies a role for the government. Although this role has never been clearly defined, a case is made for government intervention because of market failures inherent in most infrastructure goods (Fourie, 2006).

Next, in Table 1 it is presented the shares of public and private and total investment as a ratio of GDP.

[2] Infrastructure goods usually have positive externalities. Large buildings may have negative externalities or a detrimental effect upon the environment

Table 1

	1970-80						1980-90				1970-90			
				Investment as a ratio of GDP				Investment as a ratio of GDP				Investment as a ratio of GDP		
	No of countries	GDP growth	GDP growth per capita	Total	Public	Private	GDP growth	Total	Public	Private	GDP growth	Total	Public	Private
Developing countries	95	4.6	2.3	20.4	10.4	10.1	2.8	20.2	9.8	10.6	3.7	20.3	10.0	10.2
Africa	46	4.0	1.3	19.7	10.9	8.8	2.7	19.9	10.4	9.5	3.4	19.7	10.6	9.1
Asia	14	5.3	3.5	18.8	7.8	11.0	5.0	22.4	9.5	12.8	5.2	20.5	8.6	11.9
Latin America	24	4.8	2.5	20.4	8.4	12.0	1.0	18.3	7.4	11.0	2.9	19.3	7.9	11.4
Europe and Middle East	11	6	4.2	25.3	15.8	9.5	3.8	25.3	12.3	11.4	4.8	24.5	14.1	10.4

1. Source: (Khan, S. Moshin , Kumar, S. Manmohan , (1997), ***Public and Private Investment and Growth Process in Developing Countries***, Oxford Bulletin of Economics and Statistics,59)

Striking information from, Table 1 is that the share of public investment in developing countries, accounts for nearly half of total investment. In industrial countries, public sector investment accounts for less than one fifth of total (18% of total GDP) (Kumar, Khan, 1997). This data raise questions, about the efficiency of public investment capital relative to private investment and its contribution to long-run growth in developing countries. We set hypothesis that growth promoting effects of infrastructure investment are less in developing countries or transitional economies, than what are in developed country like US economy.

1.5 Theory

1.5.1 Impact of infrastructure

In general, infrastructure investment confers numerous theoretical benefits and cost, on society, by impacting economic efficiency and the, environment.

1.5.2 Impact of infrastructure investment on efficiency

Infrastructure may influence economic growth in three ways (Fourier, 2006): two of them affect the supply- side of the economy; the other affects, demand.

- *Direct effect*- Infrastructure lowers the cost of inputs in the production process(e.g. cheaper electricity lowers the cost to manufacturing industries)
- *Indirect effect*- Infrastructure improves the productivity of other input factors (for example, efficient railways, connecting residential with commercial areas would increase workers' productive time.
- Infrastructure investment creates demand for jobs or it boosts the long –term creation of jobs for semi-skilled or skilled workers which are needed for the project;

The issue of efficiency is met in these papers and in the whole literature of economic growth. Aschauer , following the example of Hulten (1996), also presented evidence which suggests that the efficiency with which public capital is utilized is just as, if not more important , than the size of the public capital stock for the economic growth process. The relationship between the effective public capital stock, k_g^e, and the actual public capital stock k_g as:

$$kg^e = \theta \cdot kg$$

θ is a measure of the average level of public capital effectiveness. The normalized efficiency measure which has a mean value, varying around zero is introduced (ε) .The average level of public capital effectiveness is given as:

$$0 = \exp(\varepsilon \cdot eff)$$

Where, *eff,* is a public capital effectiveness measure (Aschauer, 1998).

1.5.3 The theoretical model

Traditional literature on economic growth typically starts from an aggregate production function in which total output depends on productive inputs and the level of technology. Hence, the growth rate it is determined by the accumulation of the productive factors and the rate of technological progress (Jimenez, 2003). In the majority of these theories a "harmless" assumption [(3)] it has been made that the economy is closed (Peletier, 1998).One simple production function that is often thought to provide a reasonable description of actual economies is the *Cobb-Douglass* function that can be written as:

$$Y = AK^{a}L^{1-a}$$

Where A>0 is the level of technology, and a is constant exponent on, the capital and labour variable which denotes marginal productivity with value $0 < a < 1$ which implies diminishing returns. The Cobb-Douglass production function can be written in intensive form as:

$$y = Ak^{a}$$

$y = \frac{Y}{L}$	-growth rate of output per unit of labour
$k = \frac{K}{L}$	-growth rate of capital per unit of labour

Note that,

$$f'(k) = Aak^{a-1} > 0, f''(k) = -Aa(1-a)k^{a-2} < 0, \lim_{k\to\infty} f'(k) = 0, \lim_{k\to 0} f'(k) = \infty$$

In which case, the Cobb-Douglass production function satisfies the properties of a neo-classical production function (Barro, 1995). Cobb and Douglas (1928) based on empirical observations, suggested that output could be related to inputs by a multivariate non-linear function [(4)] (Ghobadian, Husband, 1990).

The function is broadest in context and can be presented in the following format:

$$P = A\{X_i^{ai} \ldots . X_i^{am}\} \quad i = 1, \ldots \ldots m$$

[3] Indeed it is true that most of the growth theories are not applicable to the real world and that exact determinants of the growth are unknown

[4] However, the assumption that all countries have same production functions, that the difference exists only in the variables, was not either tenable or appealing (Islam, 1998).

1. P=output
2. X_i=level of *ith* input factor
3. A and a_i are parameters to be estimated

The constant term A is an efficiency parameter because it determines the position of the isoquant. Next the theoretical model it is extended into a public goods model for decentralised economy.

1.5.4 The public –goods model of Productive government services

The assumption is that the government purchases a proportion of private output and then uses these purchases to provide free public services. Again, as in Barro (1990), production function for the firm *i* take the Cobb-Douglass form:

$$Y_i = AL_i^{1-a} \cdot K_i^{a} \cdot G^{1-a} \qquad 0 < a < 1$$

For a fixed G (total government purchases), the economy faces diminishing returns to the accumulation of government capital. And this equation implies [5] constant returns to scale in the private inputs, L_i and K_i.

On the next graph are presented the relationship between government size and growth rate:

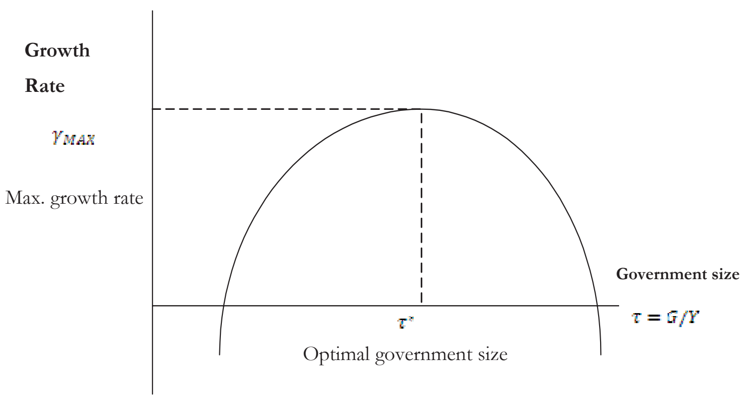

Figure 1 Government size and economic growth

[5] This production function also implies that the public services are complementary with the private inputs in the sense that an increase in G raises the marginal products of L_i and K_i.

Government and growth The relation between the size of government, and the per capita growth rate, γ is inverse. At low values of government size the positive effect of more G/Y on capital's marginal product dominate, and hence γ rises with τ (Barro, 1995).

1.5.5 The congestion Model of Productive Government Services

The key feature in the analysis is that public goods are durable goods, subject to congestion (Turnovsky, Fisher, 1998). Many governmental activities, such as highways, water systems, police and fire services, are subject to congestion. For a given quantity of aggregate services, G, the quantity available to an individual declines as other users congest the facilities (Barro, 1995). In what follows it will be assumed that they are congested when an excessive use of them is made, because this category includes, the majority of public services (Piras, 2001). Examples of public goods of this kind are highways, national parks, which get overcrowded as more people use them, but national defence, according to Barro and Sala-i-Martin (1992), could also suffer from congestion externalities (Turnovsky, Fisher, 1998). The effect of public capital on private capital is taken into account, and it is shown that in the presence of congestion the effect of government capital on private investment involves a trade off between the degree of substitution between private and public capital in production and the degree of congestion (Turnovsky, Fisher, 1998). For governmental activities that serve as an input to private production process, the congestion can be modelled for the *ith* producer (Barro, Salla I Martin, 1995).

$$Y_i = A \cdot K_i \cdot f(G/Y) \qquad i = 1,2..........m$$

Number of producers, where $f' > 0$ and $f'' < 0$.The production process is AK modified by the term that involves public services: an increase in G relative to aggregate output, Y, expands for a given Y_i (output) for a given K_i.(aggregate private capital).

While the production function for each individual producer can be written as:

$$y = Ak\left(\frac{G_k}{K}\right)^a \quad A > 0; 0 < a < 1$$

$y = \frac{Y}{L}$ -growth rate of output per unit labour

$k = \frac{K}{L}$ -growth rate of capital per unit labour

- k is private capital stock to labour ratio, G_k is the stock of public capital
- K is the aggregate stock of private capital i.e. K=N/k,
- N is the constant number of producers, normalized to one,
- *a* is the elasticity of output with respect to G_k .

In this model of congested public goods, for a given amount of public capital, the quantity available for each producer decreases if the other producers increase their level of activity (Piras, 2001).This is because of the assumption that the government keeps the ratio of public to aggregate private capital fixed, and every producer faces constant returns production function. The concept of congestion is introduced by the authors of the empirical studies, through the government size variable which is introduced in our representative model in 1.5.7 also (see Figure 1). Positive and statistically significant effect of public capital on growth may point out the fact that public capital has not reached the saturation point, otherwise marginal increments will not have impact on output since they no longer cause reduction in congestion (Sanchez, Robles, 1998).

Empirical papers in this literature typically use Solow model when diminishing returns to scale [(6)], and endogenous growth models, when constant returns to scale [(7)], both types of models are based on modified Cobb-Douglas production function. Relevance of endogenous growth theory is that, government can influence technology and hence growth rate. Next, follows explanation of how government policies can have temporary, effects on growth rates in the Solow Swan model.

1.5.6 Policy implications

Solow (1956), argued that the policy side it may take deliberate action to maintain full employment. But the multiplicity of routes to full employment, via tax expenditure, and monetary policies, leaves the nation some leeway to choose whether it wants high employment with relatively heavy capital formation, low consumption, rapid growth; or the reverse; or some mixture[(8)].Next follows our econometric design of the typical growth equation, which is derived from the theory along with the additional explanatory variables.

[6] See Appendix 1; point 2 exogenous savings rate growth models, and 2.1. steady state concept
[7] See Appendix 1, point 1, 1.2, 1.3 endogenous growth models and AK model
[8] And it cannot be suggested that kind of policy (e.g. cheap money and budget surplus) can be carried on without serious strains

1.5.7 Econometric design

We can outline our empirical model as follows:

$$growth = const + \beta_1 initialoutput + \beta_2 publicandprivatecapitaltoGDPratio + \beta_3 convergence + \beta_4 debt + \beta_5 inflation + \beta_6 openness + \beta_7 termsoftrade + \beta_8 realexchangerate + \beta_9 governmentsize + \beta_{10} polinstfactors. + \ldots + \beta_{11} humancapital .... + errorterm$$

Not all studies us this equation; indeed not one study uses exactly this equation. However, this is representative in the sense that a core of variables directly from growth theory, which appear in most growth models, are in this model. Next, this model is augmented with a substantial list of growth related variables. The list of augmenting variables varies from study to study. In spite of these differences, all of the studies in this literature have in common the inclusion of one or more variables representing infrastructure [(9)]. Next, what follows is a section on the explanation of some of the variables in the model.

1.5.8 Initial output

Growth rate of real GDP per capita is a function of initial and steady-state real GDP per worker (see Appendix 1 section 2.1 explanations on the term steady-state real GDP per worker). Poorer economy with lower initial output has higher growth rate. Expected sign on β_1 is negative from the theory, because countries with lower initial output, grow faster than countries with higher initial output.

1.5.9 Public and private infrastructure capital to GDP ratio

This variable is our main variable of interest, and it is a proxy for infrastructure capital. Theory predicts positive association between infrastructure investment and growth of GDP. Therefore the expected sign on β_2 is positive.

[9] The growth effect of these variables in the literature as a whole will now be evaluated with MRA.

1.6 Convergence rate

The research on convergence has been through a several stages, at first represented by works of Baumol (1986); convergence was studied under the assumption that all countries of the sample have same steady-state levels of income. This notion later came to be known as *absolute convergence*. Mankiw *et al* (1992) introduced the concept of *conditional convergence*. It has been emphasized that the growth theory now did imply identical steady-state levels of income [10].The main economic implications from the two concepts on convergence are:

- *Absolute convergence*-poor economies tend to grow faster than the rich ones.
- *Conditional convergence*-If a rich economy has a higher saving rate than a poor economy, than the rich economy may be proportionately further from its steady-state position.

In sum the Solow model addresses per capita income convergence (Clavusoglu, Tebaldi, 2006). Solovian models are both empirically [11] and theoretically progressive:

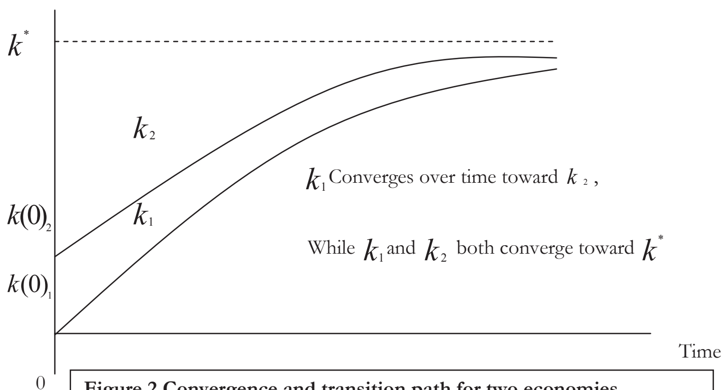

Figure 2 Convergence and transition path for two economies

k grows faster in economy 1 because $k(0)_1$ is less than $k(0)_2$ for the economy 2 . k_1, converges over time to k_2 . Therefore the expected sign on β_3 is negative form the theory.

---

[10] However, differences in steady-state were considered under the assumption of parametric homogeneity of the underlying production function (Islam, 1998).

[11] In the empirical models of the selected literature majority of papers or maybe all of them include variables from the Solow model including measure of speed of convergence towards steady-state.

In the empirical papers, $\lambda = (n + g + \delta)(1 - a - b)$ is the speed of convergence, which is proxy for convergence variable. In this variable rate of depreciation (δ) is observable, data on population growth (n) are available, data on the rate of technical progress (g) are not observable. This data are derived from the growth accounting exercise. The initial output variable incorporates the process of convergence. The variable convergence rate in this MRA (***con_r***) is combined variable of initial output and convergence in the coded papers. The growth rate it is determined by the accumulation of the productive factors and the rate of technological progress (Jimenez, 2003). The growth rate of GDP per worker grows depends on technological progress, g, and growth of capital per worker (Barro, 2008) [12]. For the purpose of the analysis in the Appendix 1 section 2.2 is the explained the basic empirical framework for the variables from the theoretical model and what follows are explanations on the additional variables and human capital used in the augmented framework of the model.

1.6.1 Government debt and economic growth, and public expenditures

Although previous studies had shown that an increase in government debt raises the real interest rate and lowers the rate of economic growth, Barro (1990) showed that increase in government spending may increase or decrease the rate of growth, in a model with productive government spending. This model is known as; the Diamond type O-G model [13] (Lin, 2000).

This model is based on an assumption that government lives forever by collecting taxes and issuing debt to finance its spending.

The effect of government debt on the per capita output is not monotonic. An introduction of government debt will increase the growth of per capita output if the growth rate is greater than the real interest rate, whereas the decrease of the growth rate happens if opposite (Lin, 2000). Therefore the expected sign on β_4 in the outline empirical model is indeterminate in theory; it may be either positive or negative.

1.6.2 Inflation and economic growth

The construction of a model to show the inflation - growth linkage is easier in theory than in practice. Usually the GDP deflator it is used as a measure for inflation (Alexander, 1997). Most papers [14] leave aside the possibility that there may be positive correspondence between inflation (above 40 percent) and economic growth (Polin, Zhu, 2006). Next, it is presented non-linear

---

[12] See Appendix 1, point 2.2. on the concept of initial level of technology

[13] It is, similar to the Uzawa –Lucas model, the economy with two goods –physical and human capital (units of effective labour).

[14] Most of the empirical studies are inconclusive about this relationship between economic growth and inflation.

relationship between inflation and growth. Initial positive relationship is on low levels of inflation, and hast to do with bounded rationality of economic agents. Generalized expectations hypothesis confirms that individuals for their forecast about the inflation are using their experience. At lower levels of inflation demand still would rise, which will cause rise in output. And negative relationship from E^2 to E^3 is due to stagflation (Gokal, Hanif, 2004). Money illusion implies that negative relationship between unemployment and inflation described by the Philips curve holds. If workers use nominal wage as reference point, firms can keep real wages lower in periods of high inflation as workers accept seemingly high nominal wages. Production is less profitable in periods of supply shock e.g. increase in the price of oil in an oil importing country, which tend to raise the prices.

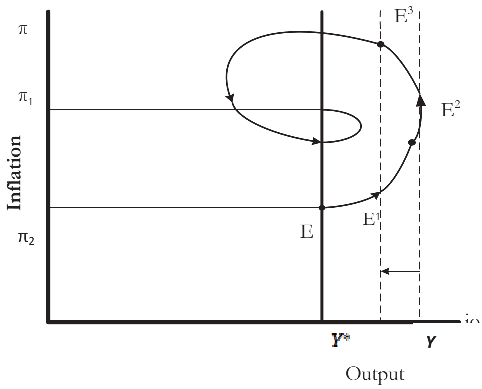

Figure 3. Inflation and growth (change in output).

In the long run, moderate steady-state inflation permits maximum employment and output. Maintenance of zero inflation measurably increases the sustainable unemployment rate and correspondingly reduces the level of output (Akerlof, Dickens, Perry, 1996). Therefore the expected sign, on the β_5 coefficient is expected to be indeterminate reflecting the non-linear relationship between inflation and growth from the Akerlof theory.

1.6.3 Trade openness and economic Growth

Economic growth requires, and does depend on openness and outward orientation, and that is why trade policies such as export promotion incentives, taking advantage of lucrative foreign markets, are increasingly becoming a must among the LDC's (Merikas, 2000). Only an open economy has the opportunity to freely export and import technological innovation and knowledge and ultimately to improve factor productivity (Merikas, 2000). Trade openness increases the competition and production of outward orientated firms in the economy, therefore the expected sign on β_6, is positive from the theory.

1.6.4 Terms of Trade and Economic Growth

The objective here it is to assume that if a country's exports are capital intensive, a country's term of trade and capital/labour ratio can evolve in the same direction, along a diversified production path. Periods of positive capital accumulation can be characterized by the terms of trade improvements (Guillo, 1999). If the price of the good that export country sells is lower than the world price, the country will export more; country's producers will produce more, which leads to a growth of GDP. Therefore the expected sign on β_7 is positive from the theory.

1.6.5 Real Exchange rate, public investment and Growth

On the empirical side, there are models that hypothesize a linear or non-linear relationship between real exchange rate (purchasing power parity) and public investment, and between the long run growth rate and public investment (Ghosh, Paya, 2003). If the growth and exchange rate are negatively associated, a rise in the real exchange rate would mean fall of the output. If it is inverted the real exchange rate relationship, so that a fall means a rise in price competitiveness, which is growth promoting, which also means rise in output. Therefore the sign on β_8 is indeterminate.

1.6.6 Government size and economic growth

As proxy for Government size in this model is taken government expenditure .Theoretically, it is suggested that larger government size is likely to be detrimental to efficiency and economic growth, the regulatory process imposes burdens and cost on the economic system and many of the government's fiscal policies tend to distort economic incentives and lower the productivity of the system (Ram, 2001). In addition, the financing of public expenditures through internal and external indebtedness, and the repression of the private financial system, has crowded out, the private sector from profitable investment activities (Ghalli, 1998). The concept of congestion is implied in this variable through the feature of optimal size of the public sector, which for the developing countries is presented in Table 1. Government size and economic growth are inversely related, therefore the expected sign on β_9 is indeterminate, because at low levels of state activity increases may be growth promoting , while at high levels of state activity increase in public sector activity may be growth detracting.

1.6.7Political and institutional factors and economic growth

Since Adam Smith it has been observed that economic performance depends in part on political and institutional factors (Sirmann, Haan, 1996). Most empirical studies point to political instability as, a hindrance for economic growth, since political instability reduces both supply of capital and supply of labour [15].Deviation of output from the implied growth rate is due to changes in technology, institutional change, and failure of the assumptions that go together with the assumption of: constant returns to scale and competitive markets for factors of production (Tamura, Baier, Dwyer, 2006).The sign on β_{10} depends on whether it is political instability in question (negative growth effect) , or political and economic freedom variable (positive growth effect).

1.6.8. Human capital and growth

Endogenous growth theory, has argued that either human capital, or trade, is primary engine of economic growth. In empirical studies, Barro (1991) and others, found evidence that human capital fostered countries long-run growth rates (Yih, 2000). The existing literature contains a number of rationales for inclusion of human capital variable in augmented framework [16] on models of economic growth. Two of them are:

1. Dynamic Cobb-Douglass production function can readily be extended to include human capital such that growth (aggregate output, per capita output) is a function of human capital.
2. Mankiw et al. (1992) demonstrated that an augmented Solow model yields a per capita income growth equation with physical and human capital investment rates, as ratios of GDP (Gemmel, 1996).

1st case suggests a role to a growth rate of HC in growth regressions, while 2nd case (MRW version) predicts a role for the *proportion of economic resources* devoted to the accumulation of HC in a growth regression rather then measures of quantity of HC inputs[17].

15 Blanka Sanchez Robles (1998) in her empirical study showed that political instability has negative impact on the growth of GDP

16 See the augmented framework of the Solow model with human capital variable included ; Appendix 1 , 2.3

17 In Romer (1990) and other endogenous models, the interaction between the technology of human capital accumulation and agent's preferences will determine the economy's rate of growth (Cabbale, Santos, 1993).

The effective labour is the sum, of skill weighted man-hours devoted to current production (Lukas, 1988).It, is generally supposed that central objective of schooling is to develop human capital, that may be needed for economic growth (Gutema, Bekele, 2004). According to endogenous growth models, (Lukas, 1988), schooling is a vehicle for human capital [(18)]. Expected sign from the theory on β_{11} is expected to be positive.

[18] Applied versions of each of these models have adopted HC measures which are similar and take for of secondary or higher schooling enrolment rate, or following Barro (1993) , many empirical studies include data on educational attainment (years of schooling or even hours).

Chapter 2

2.1 Model Specification

Following, Jarrell and Stanley (1989), and considering Stanley (2001), and recommendations from Pugh and Coric (2008), about the degrees of freedom, the MRA model has the following functional form [19]:

$$tstat = \text{int} + \beta\sqrt{DF_j} + \sum \alpha_k Z_{jk} + u_j \qquad j = 1,2 \ldots L \quad k = 1,2 \ldots M$$

$$cooel = \beta_0 + \beta_1 (1/S_{ei}) + e_i$$ Or tstat as effect size $$t_1 = \beta_0 + \beta_1 (1/S_{ei}) + e_i$$

- $j = 1, \ldots\ldots 346$ Indexes the regressions in the literature;
- $k = 1 \ldots\ldots\ldots 22$ indexes the moderator variables ;
- $cooel$ - is the coefficient on the growth variable in log-log functional form;
- Int- intercept term
- DF_j – is the degrees of freedom of *j*-th regression
- β - is the coefficient to be estimated and measures the relationship between the square root of degrees of freedom and the effect size;
- Z_{jk} – are moderator variables which reflect the main data and characteristics of j-th regression
- a_k – are k coefficients to be estimated , each of which measures the effect of a moderator variable on the effect size;
- u_j, e_i – are the usual residuals in the regression,
- L –represents the number of studies
- $(1/S_{ei})$- is the inverse of standard error,
- t_1 -is the usual t-statistics

[19] In chapter three will be presented the final parsimonious model which will be tested by different econometric techniques

2.2 Variable of interest

The variable of interest in this meta-regression is public capital (infrastructure). To be more precise it is, the public capital to GDP ratio. Studies are compared, and results are combined. Meta-analysis usually is done if the author is not certain about the result from one particular study. And when these studies are heterogeneous, straightforward combination of the test results may be too simplistic, and more sophisticated techniques should be used (Kulinskaya, Morgenthaler, Staudte, 2008).

2.3 Effect Size and controlling for degrees of freedom

After compiling the set of relevant studies a summary statistic of the effect size has to be chosen

- to combine and compare the effects size of the studies to find their mean value and test their significance
- and as the dependent variable of the MRA

Stanley and Jarrell (1989) recommended that, in economics, the *t-value* of regression is the natural effect size. The effect size approximates the standard normal distribution N~ (0, 1), under the null hypothesis of no effect. The t-statistics has no dimensionality, and it is standardized measure on the parameters of interest. Statistical theory predicts relationship between t-ratio and, the squared root of the degrees of freedom [20].The formula for the t-value on the estimated coefficient $\hat{\beta}_i$ is as follows where the denominator, in the square brackets is the standard error of $\hat{\beta}_i$:

$$t_{\hat{\beta}_i} = \frac{\hat{\beta}_i}{\left[\dfrac{\left(\sqrt{\sum \hat{u}_i^2 \frac{1}{\sqrt{df}}}\right)}{\sqrt{\sum (x-\bar{x})^2 \left(1-R_i^2\right)}}\right]}$$

[20] According to Stanley (2005), to test for an authentic relationship the square root of degrees of freedom should be used instead degrees of freedom.

DF gives the difference between the number of observations and number of independent variables in the model. Positive or negative statistically significant association between the squared root of the degrees of freedom and the t-statistics is known as existence of the authentic empirical effect.

Earlier studies that employ different monetary indices, cannot be compared. Therefore the effect size is chosen to be a pure number to avoid that problem, for the variable of interest.

2.4 Moderator Variables

MRA synthesizes the empirical literature by identifying important study characteristics or model specifications and reflecting those differences in Z_{jk}. The types of elements that make up the Z_{jk} might include:

- Dummy variables which reflect whether potentially relevant independent variables have been omitted from or included in the primary study;
- Specification variables that account for differences in functional forms , types of regressions, and data definitions and sources;
- Sample size
- Selected characteristics of the authors of the primary literature;
- Measures of research or data quality;

Publication Bias

2.4.0 Defining Publication Bias

"Many other commentators have addressed the issue of publication bias.

. . . All agree that it is a serious problem" (Begg and Berlin, 1988, p. 421) cited in (Stanley, 2005)

Many authors point out that, publication bias is like new formulation of Gresham's law, bad research drives out good research. Publication bias or, the "file drawer problem" is the consequence of choosing research papers for the statistical significance of their findings [(21)] (Stanley, 2007). It has been argued that academic or refereed journals have a, tendency to publish papers with statistically significant results. Statistical significance is judged by whether, the t-ratio of the explanatory variable is higher, or exceeds 2 in absolute value (Card, Krueger, 2001). There is natural tendency of reviewers and editors to look more favourably on the studies with statistically significant results. Studies that find relatively small and "insignificant" results tend to remain, in the "file drawer" [(22)].

2.4.1 Sources of Publication Selection

Generally on the notion on file drawer problem, are identified three sources of publication selection in economics:

- Researchers or editors maybe are, predisposed to accept papers consistent with the conventional view.
- Researchers may use the presence of conventionally expected results as a model selection test.
- And "statistically significant" results are treated more favourably.

[21] Or, publication bias is a tendency to publish studies depending on the magnitude, direction and statistical significance of the results (McDaniel, Rothotein, Whetz, 2006).
[22] With meta-analyses, statistical methods can be employed to identify/ or accommodate these biases.

2.4.2 Methods of detection of Publication Bias

The standard errors (Ses) are predictably larger in small samples, and the studies that use small samples will find it more difficult to produce the needed significant results [23]. The simplest and most commonly used method of detection of publication bias is an informal examination of a *funnel plot*. A funnel graph is a scatter diagram of precision, versus non-standardized effects, for example: inverse of the, standard error (1/Se); or the square root of the degrees of freedom. Usually, if the plot is over weighted on one side or another that is taken as evidence of publication selection. Checking graphs is later complemented by a simple MRA between the study's reported effects (reported elasticities, regression coefficients), and its standard error:

$$\text{effect} = \beta_1 + \beta_0 S_{ei} + e_i$$

Publication bias is proportional to the standard error [24]. If we suppose that journals follow a rule of publishing paper where t-ratio is higher than 2. Since the t-ratio is $t = {}^{b}/_{S_e}$, the process will generate positive correlation across studies between coefficient estimates and their associated standard errors (Card, Krueger, 2001). The functional forms are all in logs and coefficients are directly comparable. Next, in a table are presented meta-regression tests, for publication bias and authentic empirical effect. Positive and statistically significant constant, β_0, α_0, is taken as

Test	MRA model	H_1 and its implications
Funnel Asymmetry	$t_1 = \beta_0 + \beta_1 (1/S_{ei}) + e_i$	$\beta_0 \neq 0$ *Publication Bias*
Precision- effect		$\beta_1 \neq 0$ *Genuine empirical effect*
Publication bias	$\lvert t_i \rvert = \beta_0 + \beta_1 (1/S_{ei}) + v_i$	$\beta_0 > 0$ *Publication bias*
filtered-effect	$corrected - t_i = \delta_1 (1/S_{ei}) + \upsilon_i$	$\delta_1 \neq 0$ *Genuine empirical effect*
Meta-significance	$\ln(t_i) = \alpha_0 + \alpha_1 \ln df_i + v_i$	$\alpha_1 > 0$ *Genuine empirical effect*
Joint precision-effect/	Both of the above RA tests	$\beta_1 \neq 0$ or $(\delta_1 \neq 0)$ and
meta-significance		$\alpha_1 > 0$ *Genuine empirical effect*

Source: Stanley, (2005)

[23] The association of publication bias and sample size forms the basis of several approaches to publication selection identification and correction

[24] It also can be tested for publication bias by testing whether there is no meaningful relationship between sample size and effect size.

evidence of Type I (t-stat regressed on inverse of the standard error) or Type II (absolute t-stat regressed on inverse of the standard error) ,publication bias. Positive or negative statistically significant coefficient on the inverse of the standard error variable is taken as evidence of authentic empirical effect.

2.4.3 Heteroscedasticity problem and authenticity and systematic publication

However, because studies use different samples and modelling variations these random estimation errors e_i will be heteroscedastic. The most obvious problem with this MRA model of publication selection (25) is known as heteroscedasticity. WLS squares (26), divides regression equation by the individual standard error, which gives:

$$t_i = \beta_0 + \beta_1 \left({}^{1}/_{S_{ei}} \right) + e_i \qquad t_b = \frac{b_j}{S_k} = \frac{\beta}{S_b} + \sum_{k=1}^{K} \frac{a_K Z_{jk}}{S_b} + \frac{u_j}{S_b}$$

$$t_i = effect_i / Se_i = \gamma_0 + \gamma_1 (1/Se_i) + e_i$$

We can interpret this equation, as a WLS of a standard regression (27).

This estimate ${}^{1}/_{S_{ei}}$, is useful test for authentic effects, or it is a measure of precision versus estimated effect (Rose ,Stanley, 2005).If , on the other hand researches finds positive association between square root of the df, and the standardized *t-statistic* across a given empirical literature, the authenticity of the effect in question is confirmed(Stanley,2007). That *authenticity* suggests absence of publication selection. The previous equation is the basis of *Funnel asymmetry test*. Since all the studies or majority of them use different data sets, different sample sizes and different independent variables, variances may not be equal. That is contrary to the assumption 5 (Wooldridge, 2006), of classical linear regression model (CLRM) (28), and therefore meta-regression errors are likely to be heteroscedastic.

[25] Theoretical papers predict that publication bias is strongly inversely related to the sample size.

[26] Weighted least squares (WLS) become the obvious method of obtaining efficient estimates of the equation between the effect size and the standard error but this time corrected standard error.

[27] Standard regression is likely to suffer from heteroscedasticity

[28] that $var(u | x_1, x_2 \ldots\ldots x_k) \neq \sigma^2$

2.4.4 Trim and fill method and sensitivity analysis

There are a number of unobserved coefficients in unpublished studies, in addition to observed studies, which are not included due to publication bias .The number of these studies and correlations (effect sizes) associated with them ,is unknown but it can be estimated. This is the *trim and fill* method. Uncertainty of the estimates of the unobserved studies has to be reflected in adjusted meta-analytic result (Mcdaniel, Rothotein, Whetz, 2006). Second, the assumption is that the distribution of the effect sizes in population is homogenous, that the sampling error is the source of variation. The trim and fill method interprets effect size distribution asymmetry as evidence of publication bias. It is impossible to estimate the selection mechanism just from the selected studies which leads to "worst case" sensitivity analysis of publication bias (Jackson, Copas, 2004). Meta analysis, concerned that publication bias may be present, can use these in sensitivity analysis, to assess the robustness of their estimates between study variance using any selection process that can be used in practice (Jackson, 2007).

2.4.5 Correcting the Publication Bias

Correcting this bias is impossible without making untestable assumptions [29].Bayesian methods for "correcting" publication bias introduced by Givens et al (1997), assumes prior distribution on the number of unpublished studies. As it is noted, direction, extent, and the impact of publication and related biases, are uncertain and may vary greatly depending on circumstances (Copas, Shi, 2000).The extreme view of the problem is that the journals are filled with, 5% of papers which show type I error, while the file drawers, are filled with the remaining 95% of the studies that show non-significant results (p>0.5) (Rosenthal, 1991). Sterling (1959) also argued that non-significant results are rarely published and therefore the published literature is full of type I errors (Hedges, Olkin, 1985).

2.4.6 Solution to the problem

Although, unlike in the past some improvements are introduced, no definitive solution to the problem can be seen. Reasonable boundaries can be established to the problem and the degree of damage can be estimated to any, research conclusion that could be done by the file drawer problem [30]. The fundamental idea in coping with the file drawer problem is to calculate the

[29] And all of the methods for correcting the publication bias are based on some assumptions.

[30] However, empirical evidence about the existence of editorial bias is not overwhelming, and that surveys of statistical power involve assumptions about effect size, for example that may not be tenable.

number of studies averaging null results (Z=0.00), that must be in the file drawers, before the overall probability of type I error, can be just brought to any desired level of significance, say p=.05. This number of filled studies, or the tolerance for future null results, is evaluated for whether such a tolerance level is small enough to threaten, the overall conclusion drawn by the reviewer (Rosenthal, 1991).If the overall level of significance of the research review will be brought down to the level of *just significant* by addition of few new more null results, the finding is not resistant to the file drawer threat [31].

2.4.7 Conclusion

All methods for detection of publication bias have low test power statistical power [32]. Even when the intercept in the model is insignificant, the existence of publication bias in the literature is still present. This is what makes potentially negligible results, to appear more important. The unreliability of testing for publication bias makes researcher's, focus upon the questions of whether there is genuine empirical effect irrespective of publication selection. Secondly, what is the magnitude of this effect and researchers' task is to address and answer these questions. Theoretically are explained FAT (Funnel Asymmetry Test), and the test for the genuine effect beyond the publication selection, which is known as PET (Precision Effect Test). Precision effect size test's high power is surprising because the meta-regression of t-values on precision $1/S_{ei}$ is known to contain errors in variables (EV's) [33]. And the reason behind this model of publication selection begins with the recognition that the researchers will select larger effect when the standard error is large (Rose, Stanley, 2005).

Coding

2.5 Papers Selection Criteria

Meta regression analysis starts with an emphasis of putting all available empirical studies (Stanley, 2001) on the three data bases: EBSCO, ECONLIT, and Blackwell Synergy (Blackwell

[31] The perception of an editorial policy that uses statistical significance as criterion for publishing manuscripts may have nearly the same effect as an actual policy to that effect.

[32] Thus, it would be unwise to use the absence of evidence of publication bias as a reason not, to adjust, or to take measures to correct it.

[33] The way that publication selection is stimulated here by selecting *t-values* that are statistically significant regardless of the sample size is more consistent with the $effect = \beta_1 + \beta_0 \, {}^1/_{S_{e_i}} + e_i$ equation and the precision effect size.

Science). Papers were also selected with criteria, to be published in refereed journals (27) studies and three working papers [34].

2.5.1 Coding the selected papers

Most of the studies reported more than one estimate or more than one regression and all the regressions were coded separately depending on:

- Multiple estimates from same study were used as separate observation if they occurred in dissimilar model (in one model was introduced new variable, so it was considered the augmented and basic model to be different).
- Or alternatively multiple estimates from same study were reported as separate observation if they occurred in one model but estimated with different techniques e.g. comparison between OLS and 2SLS or some other estimation techniques

From the set of 30 studies 346 observations are obtained and going to be estimated in model [35]. In these papers was not reported, the diagnostics i.e. testing for heteroscedasticity, linear functional form, and test for normality of the residuals. In some papers were reported robust standard errors, and was conducted some test for endogeneity [36]. Authors do not specify preferred regression, and all of the regressions are reported. The papers contain wide variety of estimation techniques applied on data from, samples of developed, developing and transitional economies, for time period from 1989 to 2008 [37]. Degrees of freedom were reported for each regression either authors of the papers report them, either the number of the degrees of freedom was calculated $DF = N * T - t - k$ (Wooldridge, 2006). The analytical method deployed for these studies is Meta-regression analysis [38]. Next, follows a chapter for the results of the empirical model.

---

34 Aschauer (1997) and Aschauer (1998) are working papers were taken in the sample of papers because they are refereed in the rest of the empirical papers and are considered to be important papers. And Deno, Eberts (1989) working paper was taken in the sample of papers because of the estimation technique (2SLS) applied

35 They are all reported in table (see Appendix 2), and year of publication and number of regressions is reported there, and the signs on the reported coefficients.

36 If it was time series model in some papers was obtained Granger causality test and in panel model Hausman exogeneity test

37 In the coding process every variable that was considered to be significant, was reported.

38 The examined are the various influences of output elasticities, found in the case studies (Stanley, Jarell, 1989).

Chapter 3

Results

3.1 Meta Analysis on the output elasticity effect size

Central consideration of meta-analysis is to test the null hypothesis, that the effect sizes are distributed standard normal, N~ (0, 1), under the null hypothesis of no effect. The null hypothesis is that the mean effect is zero. The hypothesised, public (private) infrastructure capital and growth relationship will be rejected, if the average effect size (average t-statistics), is not significantly different from zero. The data set of this MRA, consists of **346** estimated output elasticises, from the collected 30 empirical studies [39]. The mean value of the t-statistic, on the coefficients on the output elasticity is **1.47**, with standard deviation of 2.63 [40]. We reject the null hypothesis, i.e. the mean **cooel** is zero at, the one percent level of significance (at probability of less than 0.0001, for type I error), t (**ACOOEL**) = **10.39**. Provisionally here, we conclude that the empirical literature review suggests, a positive relationship between growth of GDP, in log terms (coefficient on the output elasticity), and the coefficient on the infrastructure capital (public and private infrastructure). This conclusion is confirmed, by the simple vote-counting procedure[41], where regressions in 22 papers find, a positive robust relationship, between infrastructure capital/GDP and GDP per capita, and in 8 papers out of the whole sample, were reported, positive and negative, correlation between infrastructure capital in per capita terms, and growth of GDP variable[42].

The null hypothesis, that the standard deviation of the effect size, is one $(\sigma = 1)$, is also tested. The variance is tested by applying Chi-square (n) procedure (H_0: $\sigma = 1$ and H_1: $\sigma > 1$), with n, as given by the number of the effect sizes. If the null is not rejected than the differences among the effect size around their mean might result from a purely random sampling error. Consequently the empirical review will be unnecessary (Kotorri, 2006). On the other hand, if the

[39] See table 1 for the number of estimation of the output elasticity effect size
[40] See Appendix 3 Meta-analysis of the effect size

[41] Among meta-analyst vote-counting is considered to be biased and obsolete (Jarrel,2001)
[42] See Appendix 2 Study characteristics

standard deviation of the effect sizes exceeds one, significantly, it suggests that variations reflect systematic differences around their mean.

In this MRA study, the variation of observed coefficients on the output elasticises around their means is considerable it ranges from, -**20.394** to **155.22**[43], with standard deviation of **10.87.** The coefficient on the t-statistics effect size varies from, -**8.89** minimum value to **13.43,** with standard deviation of **2.63**. The null hypothesis $(\sigma = 1)$, is rejected at a probability less than 0.0001[44], of making type I error [45]. This is an argument to the explanation that, the variations of the output elasticises around their mean are a result of systematic differences in model specification. The purpose of Meta-regression analysis technique is to explain these systematic, study-to-study variations. Earlier in chapter 1, were explained the variables in the augmented model, or the variables that the author of this meta-regression, based on his a priori knowledge about the growth theory, and usual models that are described in estimated in growth empirical papers, here those variables will be presented in a table of summary statistics (see Appendix 4).

3.2 Descriptive statistics of the model

First of all, the majority of the models are conducted in a cross-section framework. Following, the example of Button (1998), meta-regression on infrastructure investment and growth, one variable was created out of pooled time series and cross-sectional data (**pool_ts_cs)**, with **panel** variable, as the benchmark (because of perfect collinearity between the two). Majority of the studies are for developed and least developed countries, **dc_ldc** (mean= **0.83**), and a variable for US studies **(us)** is needed, and also for the transitional economies. However, because of the near perfect collinearity between **us** and **dc_ldc,** variable, we use the latter to capture the effect on **cooel**, the dependent variable.

In addition for the explanation, these are moderator (independent) variables, that can be continuous or binary, which reflect the presence (1), or absence (0), of one study characteristic.

The definition of the independent variable of the interest followed from the theory. The variable public infrastructure capital (in the papers **pubc/gdp** or **gov/per capita**) was combined

43 These figures are part of a summary statistics in STATA 10 later will be reproduced one table of summary statistics.
44 By conventional criteria, this difference is considered to be extremely statistically significant
45 See Appendix 3 Meta-analysis of the effect size

with private infrastructure capital in per capita terms, creating one variable, **pubc_priv_gdp,** which is our main variable of interest. This variable (with mean =**0.945)** and two additional variables, which proxy infrastructure capital, telephones per million inhabitants(**tpminh**), and paved roads per million kilometres squared **(pvd_rds_pmkmsq),** and government size (investment and current spending) (**gsics**), represent the infrastructure investment in per capita terms. Following the theory, that the concept of initial capital (initial GDP per capita) is implied in the concept of *absolute convergence* [(46)], two variables were combined into one variable, implying convergence across countries and regions (**con_r).** The, **con_r**, variable, has mean value of **0.739,** meaning that the variable, is present in **74**%, of the observations reported from the studies.

Observations, for the years of schooling, (**yssch**), and hours of schooling (**hrsch**), are combined into one single variable (**human)**, which serves as a proxy for human capital in the model. This variable has a mean, **0.13**. In combining the two variables into, a single human capital variable, theoretical (a priori), knowledge was taken into account again.

Next, the variable (**aardaehstcihmm_gdp),** which denotes public expenditures, or investment in: defence, agriculture, education, health, social expenditures, transport and communication, housing and mining, manufacturing, as percentage to GDP. This variable has mean of **0.245.** This variable is present in **24.5**% of the regressions reported in the MRA data set. Next, the real exchange rate variable has mean of **0.023**, and standard deviation of **0.151.**

Continuous variables are included for testing the authentic empirical effect in the MRA analysis following the recommendations of Pugh and Coric (2008), and Stanley (2008): the square root of the degrees of freedom (**sqrtdf**, mean=**15.86**; sd=**9.45**); inverse of standard error, (**inv_se**), **abst,** absolute t-statistic variable; and **ldf**, or log of degrees of freedom from the studies. Summary statistics for the variables are presented in appendix 3, together with the variables explanations.

3.3. Results

Functional forms, regarding the Stanley (2008) recommendations, about the inverse of the standard error, were presented in Chapter 2 [(47)].However, the squared root of the degrees of freedom has also been used, following recommendations of Pugh and Coric (2008), and Stanley (2001), to asses the authentic empirical effect. Given the importance of the functional form, were tried different specifications of the given, hypothesized correlation, in the literature for the meta-

[46] See explanation about the absolute and conditional convergence pp. 10

[47] See pp.16

regression analysis [48]. To choose the best model diagnostics testing procedures were conducted. Most importance was given to the functional form, followed by heteroscedasticity, and collinearity. Heteroscedasticity problem was corrected with robust standard errors, while collinearity was corrected with combining some of the variables, or by excluding them, as a last action that can be taken, even though not preferable. Multicollinearity is a problem that occurs when explanatory variables display little variation and high inter-correlations (Maddala, 2001).

As it can be seen from the table of diagnostics of the parsimonious model, mean **VIF=2.04**, for the robust standard errors OLS model. And for the cluster robust standard errors model mean **VIF = 1.82**.Maximum VIF in the two models is **5.26** and **3.76** respectively. Mean variance inflation factor for the Weighted Least Squares model and Clustered Robust Weighted Least Squares model, is estimated to be **3.39** and **1.72** respectively for the two models. These indicators are not high; we conclude that following a rule of thumb, maximum individual **VIF** to be less than **10** and the mean **VIF** to be not considerably larger than 1 (Stata corp. Reference Q-Z)**.** Explanatory power of these two models is satisfactory, R^2 (R-squared) of these two models ranges from **0.43** to **0.52,** for the OLS and Cluster-Robust OLS, and WLS (Weighted Least Squares) and Cluster-Robust Weighted Least Squares. Functional form of these models is of particular importance. The Ramsey reset test using powers of the fitted values of the dependent variable, with null hypothesis H_0: model has no omitted variables, showed that in the OLS and Cluster Robust OLS and WLS and Cluster Robust WLS, the probability of type I error is **0.17**and **0.14** respectively. This is an argument which can be used in support of the claim that the models are well specified. Cameron & Trivedi's decomposition of Information Matrix test is available only for the robust OLS. Next in Table 2, are summarized results for this regression-t-statistics is regressed on the inverse of the standard error (see Appendix 5). Table 2 continued reports regression diagnostics.

[48] These hypothesized relationships are presented in the pp.20 in a table Jarrel, (2005).

Table 2 Meta –regression of the infrastructure capital effect on growth of GDP

Table 2		Summarized results from the parsimonius model (342 observations ,from 30 studies)							
Dependent variable tstatistics		OLS	P>|t|	Clustered Robust OLS	P>|t|	WLS	P>|t|	Clustered Robust WLS	P>|t|
	t-stat	coeff		coeff		coeff		coeff	
inverse of the standard error	1.inv_se	-0.0004	0.133	-0.0004	0.116	-0.0002	0.462	-0.00023	0.430
endogeneity	2.endogeneity	-0.445	0.111	-0.44	0.343	-0.53	0.133	-0.53	0.384
pooled times series cross section data	3.pool_ts_cs	0.54	0.049	0.53	0.200	-0.08	0.798	-0.08	0.875
foreign direct investment	4.fdi	-0.87	0.286	-0.87	0.537	-1.40	0.078	-1.40	0.23
us studies	5.us	1.31	0.001	1.31	0.017	0.90	0.021	0.90	0.152
regional studies	6.reg_s	-0.999	0.000	-0.999	0.097	-1.28	0.000	-1.28	0.075
transitional economies	7.trans_e	-3.13	0.000	-3.12	0.003	-3.41	0.000	-3.41	0.000
public and private infrastructure capital to GDP	8.pubc_priv_gdp	-0.31	0.469	-0.30	0.588	-0.37	0.504	-0.37	0.593
convergence rate	9.con_r	-0.41	0.292	-0.41	0.501	-0.004	0.993	-0.004	0.996
telephones per million inhabitants	10.tpminh	2.25	0.029	2.25	0.144				
real exchange rate	11.rer	-2.288	0.002	-2.29	0.020	-1.83	0.050	-1.83	0.085
government size investment and current spending	12.gsics	-2.85	0.000	-2.84	0.000	-3.23	0.000	-3.23	0.000
average annual ratio of defence, agr,soc,health,mining expenditure to GDP	13.aardaehstcihmm_gdp	-2.005	0.000	-2.00	0.001	-1.95	0.000	-1.95	0.003
average ratio of electricity net value	14.aroenv	-1.75	0.000	-1.75	0.014	-1.54	0.013	-1.54	0.075
capacity utilization	15.c_util	3.73	0.048	3.73	0.003	4.04	0.026	4.04	0.002
human capital	16.human	-0.39	0.108	-0.39	0.338				
budgetary deficit as percentage to GDP	17. bdp_gdp	-1.91	0.000	-1.91	0.001	-1.86	0.000	-1.86	0.002
political and ecvonomic freedom	18.pol_efr	-0.65	0.258	-0.65	0.420	-1.005	0.069	-1.005	0.189
openess	19.opennes	1.6	0.014	1.60	0.096	2.20	0.000	2.20	0.004
intercept	20.constant	2.9	0.000	2.89	0.002	3.21	0.000	3.21	0.001
R-squared		0.52		0.52		0.42		0.42	
Ho: model has no ommited variables- (prob of type I error is reported)		0.17		0.17		0.14		1.14	
Mean VIF		2.04		1.82		3.48		3.48	
F-test		F(19,322)=27.83		n.a.		F(17,324)=22.38		n.a.	
Prob>F		Prob > F = 0.0000		n.a.		Prob > F = 0.0000		n.a.	

Table 2 continued diagnostic tests for the two models

Table 2 continued									
		OLS Robust standard errors	P>|t|	Clustered Robust OLS	P>|t|	WLS	P>|t|	Clustered Robust WLS	P>|t|
Dependent Variable t-stat		coeff		coeff		coeff		coeff	
Maximum VIF		5.26		3.76		9.20		3.48	
Mean VIF		2.04		1.82		3.39		1.72	
Ramsey RESET test using powers of the fitted values of tstat	Ho: model has no omitted variables	F(3, 319) =1.69	0.1681	F(3, 319) =1.70	0.1681	F(3, 321)=1.82	0.1431	F(3, 321)=1.83	0.1431
Cameron & Trivedi's decomposition of Information Matrix test	Ho: homoskedasticity	chisq=153.77	0.0000	n.a	n.a	n.a	n.a	n.a	n.a
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no nonnormal skewness	chisq=45.89	0.0005	n.a	n.a	n.a	n.a	n.a	n.a
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no nonnormal kurtosis	chisq=5.51	0.0189	n.a	n.a	n.a	n.a	n.a	n.a

This test (Cameron & Trivedi's decomposition of Information Matrix test), showed evidence of heteroscedasticity. Probability of type I error when rejecting the null hypothesis of homoscedasticity is **0.0000**, according to the White's Standard original test. This problem is corrected (tackled), by reporting robust standard errors. This usually can be solved by applying an alternative functional form, (e.g. log-log), but having in mind that our dependent variable contains negative values, later specification is inappropriate because it will cause sampling bias. While the alternative (lin-log) functional form is also a possibility, after it was tried the Ramsey reset test showed that the model is not well specified, with respect to that specification. F-test showed, joint statistical significance of the variables, probability of type I error when rejecting the null hypothesis of insignificant variables is **0.0000** .This test is not available in **STATA** for OLS clustered robust and WLS clustered robust errors. F-test in robust WLS regression showed that probability of rejecting the null hypothesis: probability of type I error of the null of joint insignificance of the variables, is also **0.0000.** This stands as evidence, in support of accepting the alternative hypothesis, of jointly significant variables.

Other potential problems with the OLS specification were also considered. First, the studies (**30**) included in this sample report different number of results. The mean number of results per study is **12.98,** while the reported regressions range from **2** to **32**. Weighting studies reporting large number of regressions more heavily than studies reporting fewer and may distort MRA results (Jarrel, Stanley, 1990). To correct for this disproportion in the results each study is equally weighted by the inverse number of the results reported by that study to weight each result from that study (WLS).Upon weighting the studies (WLS), is applied to the MRA model. Stanley's suggestion will be considered on weighting studies individually and weighting the individual results to see if there is any difference.

The reported results in the study are sampled independently and not individually, which causes the second problem. Adding cluster robust estimates to both OLS and WLS estimates, relaxes the assumption of independence between observations within group, but requires that observations be independent between groups (Kotorri , 2006) [(49)]. Next in Table 3 are presented results (coefficients as well as p-values, to denote level of significance), when variable; output elasticity is regressed on the inverse of the standard error (see Appendix 6). Table 3 continued, contains diagnostic test for the regression.

[49] This method produces "correct" standard errors "even if the observations are correlated" (Stata. Corp for WLS allows for sampling or pweights (probability weights).

Table 3. output elasticity regressed on the inverse of the standard error

		WLS	
Dependent variable output elasticity (cooel)		Coeff	P>|t|
Inverse of the standard error	1.inv_se	-9.36E-07	0.280
Endogeneity	2.endogeneity	-0.033	0.128
Pooled time series cross section data	3.pool_ts_cs	0.013	0.624
Foreign direct investment	4.fdi	-0.022	0.076
US studies	5.us	0.076	0.059
Regional studies	6.reg_s	-0.013	0.339
Transitional economies	7.trans_e	4.30	0.559
Public and private infrastructure capital to GDP	8.pubc_priv_gdp	0.20	0.000
Convergence rate	9.con_r	-0.21	0.000
Real exchange rate	10.rer	-0.033	0.386
Government size investment and current spending	11.gsics	-0.028	0.014
Average annual ratio of defence agr, educ, health exp. to GDP	12.aardaehstcihmm_gdp	-0.045	0.008
Average ratio of electricity net value	13.aroenv	0.28	0.000
Capacity utilisation	14.c_util	0.42	0.000
Budgetary deficit as percentage to GDP	15. bdp_gdp	0.04	0.386
Debt	16.debt	0.03	0.014
Efficiency	17. efficiency	0.09	0.008
Openness	18.opennes	-0.03	0.159
Political and economic freedom	19.pol_efr	0.02	0.641
Population growth	20.pop_gr	-0.013	0.316
Black market premium	21.bmp	0.006	0.374
Paved roads per million kilometres squared	22.pvd_rds_pm~q	-0.046	0.457
Intercept	23._cons	0.06	0.024
R-squared		0.0948	
Ho: model has no omitted variables- (prob of type I error is reported)		F(3, 312) = 2.60 Prob > F = 0.05225	
Mean VIF (Variance Inflation Factor)		4.38	
F-test		F(22, 315) = 24.26	
Prob>F		Prob > F = 0.0000	

Source; Stata 10

Table 3 continued Diagnostic tests

Table 3 continued

		WLS Robust standard errors	P>|t|
Dependent Variable cooel		coeff	
Maximum VIF (Variance Inflation Factor)		13.48	
Mean VIF (Variance Inflation Factor)		4.38	
Ramsey RESET test using powers of the fitted values of tstat	Ho: model has no omitted variables	F(3, 312) = 2.60	0.052
Cameron & Trivedi's decomposition of Information Matrix test	Ho: homoskedasticity	n.a.	n.a.
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no non normal skewness	n.a.	n.a.
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no non normal kurtosis	n.a.	n.a.

From the diagnostics in **Table 3 continued**, for the WLS robust regression, it can be seen that functional form is correctly specified. Ramsey reset test showed that probability of type I error when rejecting the null hypothesis is **0.052,** which suggests **5%** probability of type I error, if we reject the null hypothesis that the model has no omitted variables. Cameron & Trivedi's decomposition of Information Matrix test was not available for this robust WLS regression. The explanatory power of the model is not high, R^2(R-squared) of the model is **0.0948** (9.48%). The mean **VIF** of this model is **4.38,** while the maximum individual **VIF** is **13.48,** which indicates presence of collinearity to some extent in the model, even though mean **VIF** is lower **4.38** , but if we recall to the rule of thumb, it should be lower than **4**. The reason that it wasn't continued with omitting variables from the model to lower **VIF** is because that action will cause problems with the functional form. To test for Type I publication bias and genuine empirical effect, irrespective of publication bias, it is embedded "Funnel asymmetry precision effect" test [(50)].Next, follows a Table 4 and Table 4 continued (see pp.34, 35), which contain summarized results of the, **t-stat** regressed on the squared root of the degrees of freedom (**sqrtdf**)[(51)], and the reported diagnostics for the model.

[50] Both in table 2 an table 4 are included inverse of the standard error and squared root of the degrees of freedom
[51] The use of the squared root of the sample size may supply more defensible estimates of publication bias.

Table4. Meta regression analysis; t-stat regressed on squared root of the degrees of freedom

	Table 4	Summarized results from the parsimonius model (346 observations ,from 30 studies)							
		OLS	P>|t|	Clustered Robust OLS	P>|t|	WLS	P>|t|	Clustered Robust WLS	P>|t|
	t-stat	coeff		coeff		coeff		coeff	
squared root of the degrees of freedom	1.sqrtdf	-0.006	0.796	-0.006	0.848	0.0084	0.750	0.0084	0.812
endogeneity	2.endogeneity	-0.48	0.101	-0.48	0.230	-0.40	0.239	-0.40	0.331
pooled times series cross section data	3.pool_ts_cs	0.60	0.077	0.60	0.221	0.07	0.848	0.07	0.905
foreign direct investment	4.fdi	-1.07	0.067	-1.07	0.365	-1.59	0.044	-1.59	0.200
us studies	5.us	1.31	0.006	1.31	0.051	0.81	0.082	0.81	0.048
regional studies	6.reg_s	1.28	0.011	1.28	0.082	-1.07	0.000	-1.07	0.001
transitional economies	7.trans_e	-3.03	0.000	-3.03	0.005	-3.5	0.000	-3.5	0.599
public and private infrastructure capital to GDP	8.pubc_priv_gdp	-0.32	0.547	-0.32	0.533	-0.35	0.507	-0.35	0.947
convergence rate	9.con_r	-0.45	0.184	-0.45	0.428	-0.04	0.931	-0.04	0.216
telephones per million inhabitants	10.tpminh	2.01	0.032	2.01	0.143	1.89	0.045	1.89	0.096
real exchange rate	11.rer	-2.18	0.004	-2.18	0.043	-1.80	0.058	-1.80	0.000
government size investment and current spending	12.gsics	-2.95	0.000	-2.95	0.000	-3.41	0.000	-3.41	0.002
average annual ratio of defence, agr,soc,health,mining expenditure to GDP	13.aardaehstcihmm_gdp	-2.01	0.000	-2.01	0.001	-2.03	0.000	-2.03	0.042
average ratio of electricity net value	14.aroenv	-1.77	0.226	-1.77	0.014	-1.73	0.006	-1.73	0.001
capacity utilization	15.c_util	3.61	0.000	3.61	0.002	3.77	0.038	3.77	0.149
human capital	16.human	-0.37	0.367	-0.37	0.347	-0.88	0.025	-0.88	0.034
budgetary deficit as percentage to GDP	17. bdp_gdp	-2.00	0.002	-2.00	0.009	-1.89	0.002	-1.89	0.942
political and ecvonomic freedom	18.pol_efr	-0.68	0.396	-0.68	0.487	-0.077	0.914	-0.077	0.121
openess	19.opennes	1.63	0.048	1.63	0.104	1.38	0.038	1.38	0.014
intercept	20.constant	2.75	0.000	2.75	0.010	2.96	0.000	2.96	0.001
R-squared		0.5086		0.5086		0.4321		0.4321	
Ho: model has no ommited variables- (prob of type I error is reported)		0.3055		0.3055		0.4212		0.4212	
Mean VIF		2.49		2.49		2.21		2.21	
F-test		F(19, 326) = 17.76		n.a.		F(19, 326) = 18.82		n.a.	
Prob>F		Prob > F = 0.0000		n.a.		Prob > F = 0.0000		n.a.	

Table 4 Continued Diagnostic test

Table 4 continued diagnostics									
		OLS Robust standard errors	P>|t|	Clustered Robust OLS	P>|t|	WLS	P>|t|	Clustered Robust WLS	P>|t|
Dependent Variable t-stat		coeff		coeff		coeff		coeff	
Maximum VIF		5.96		5.96		5.54		5.54	
Mean VIF		2.49		2.49		2.21		2.21	
Ramsey RESET test using powers of the fitted values of tstat	Ho: model has no omitted variables	F (3, 323) = 1.21	Prob > F = 0.3055	F (3, 323) = 1.22	Prob > F = 0.3056	F(3, 323) = 0.94	Prob > F = 0.4212	F(3, 323) = 0.94	Prob > F = 0.4212
Cameron & Trivedi's decomposition of Information Matrix test	Ho: homoskedasticity	chisq=117.14	0.0001	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no nonnormal skewness	chisq=35.91	0.0108	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no nonnormal kurtosis	chisq=6.97	0.083	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Functional form for the models outlined in the above tables, is correctly specified. Probability of Type 1 error, when rejecting the null hypothesis, of no omitted variables is **0.31**, and **0.42**, respectively**.** Collinearity is not a problem among the independent variables; the mean VIF for the OLS and Cluster Robust OLS, WLS and Cluster Robust WLS, is **2.49** and **2.21** respectively. F–test shows joint significance of the independent variables in the OLS and WLS model, probability of type 1 error when rejecting the null of insignificant variables is **0.0000**, for the two specifications[(52)]. R^2(R-squared) goes from **0.42** (WLS and Cluster Robust WLS), to **0.51**, which is good explanatory power, but it's of second importance, first comes the functional form. Next, follows interpretation of the models.

[52] See Table 4 pp.34 or see Appendix 7 t-stat regressed on the squared root of the degrees of freedom printout for the regressions from STATA 10

Regression coefficients reflect the partial effect of a particular independent variable on the dependent variable holding everything else constant.

Coefficient on moderator variable controlling for ***endogeneity*** is negative and statistically significant, at **10%** level of significance in the OLS regression (**Table 2** and **Appendix 5**), and this coefficient is negative and statistically significant in model presented in **Table 4**(53).The significant negative coefficient means that regressions controlling for endogeneity are less likely to report a positive effect of infrastructure on growth. Typically, regressions controlling for endogeneity will report t-statistics lower by **0.38** or **0.39**.

The moderator variable for studies using pooled, time series, cross-section data (***pool_ts_cs***), is positive and statistically significant in OLS models (**tstat** on **inv_se** and **tstat** on **sqrtdf** (54)). This means that on average studies using such data find, more positive infrastructure capital and growth of GDP relationship, compared to studies using panel data. Typically, regressions controlling for pooled time series cross section data, will report t-statistics lower by **0.03** or **0.23**.

The moderator variable for studies using Foreign Direct Investment (***fdi***), in the models, is negative statistically significant in WLS specification. This means that on average studies controlling for this variable, find less positive association between infrastructure capital and growth of GDP. Typically, regressions controlling for **fdi** will report t-statistic lower by **0.23**.

The moderator variables for US studies (***us***), is positive and statistically significant in all the outlined models , except in clustered robust WLS model outlined in Table 2, where is positive and insignificant. This means that on average studies using such data find, more positive infrastructure capital and growth of GDP relationship, compared to studies using developed and least developed countries in the sample (***dc_ldc***).

The moderator variable for regional studies (***reg_s*),** is negative and statistically significant in all the models, except in the OLS specification in **Table 4**. On average this means that studies controlling for this variable find less positive association between infrastructure capital and growth of GDP.

The moderator variable for transitional economies (***trans_e***), is negative and statistically significant, except in model presented in **Table 3**, where it is positive and insignificant. This means that on average, studies that do control for this variable, find less positive association between infrastructure capital and growth of GDP.

The Moderator variable for the independent variable of interest (***pubc_priv_gdp***), is positive and statistically significant (see **Table 3**). Which is in line with conclusion, that empirical literature

[53] When t-stat regressed on squared root of the degrees of freedom
[54] See Appendix 7

review suggests, a positive relationship between growth of GDP and the infrastructure capital (public and private infrastructure) [(55)].

The moderator variable for convergence (***con_r***) is negative and significant in model outlined in **Table 3**, while in other specifications is negative and insignificant. This means that studies that do control for convergence, on average find a less positive association between infrastructure capital and growth of GDP.

The moderator variable for telephones per million inhabitants (***tpminh***) is positive and statistically significant, except in model outlined in **Table 3** where it is dropped. This means that on average studies that control for this variable find a more positive association between infrastructure capital and growth of GDP.

The moderator variable for real exchange rate (***rer***), is negative and statistically significant, except in the model in **Table 3**, where is negative and insignificant. This means that on average studies that control for this variable, find less positive association between, infrastructure capital and growth of GDP.

The coefficient on the moderator variable for government size investment and current spending (**gsics**) is negative and much statistically significant (t>2), in all of the models outlined above. This means that studies that control for this variable, on average find less positive association between infrastructure capital and growth of GDP. Typically, regressions that control for this variable report higher t-statistics.

The moderator variable for defence, education, health, social and other types of expenditures as a percentage to GDP (***aardaehstcihmm_gdp***), is negative and statistically significant in all of the outlined specifications. This means that studies that do control for this variable, on average find less positive association between infrastructure capital and growth of GDP.

The moderator variable for average ratio of electricity net value (***aroenv***), is negative and significant, except in model outlined in **Table 3**, where is positive and significant. On average studies that do control for this variable, find less positive association between infrastructure capital and growth of GDP.

The moderator variable that control for capacity utilization (***c_util***), is positive and statistically significant. This means that studies that do control for this variable on average find more positive association between infrastructure capital and growth of GDP.

[55] See Appendix 3

The moderator variable for human capital (***human***) is negative and significant in the OLS specification in **Table 2**, and negative also significant in the WLS specification in **Table 4**, while in other specifications is negative and insignificant. This means that on average studies that control for this variable find a less positive association between infrastructure capital and growth of GDP.

The moderator variable for budgetary deficit as proportion to GDP (***bdp_gdp***) is negative and significant in model outlined in **Table 4**, while in other models this variable is insignificant. On average studies that control for this variable present a less positive association between infrastructure capital and growth of GDP.

The moderator variable for political and economic freedom (***pol_efr***) is negative but insignificant, in the outlined models, at the conventional levels of acceptance. On average, studies that control for this variable, find less positive association between infrastructure capital and growth of GDP.

The moderator variable for openness (***openness***) is positive and significant in model outlined in **Table 2**, and OLS specification in **Table 4**, otherwise is insignificant. On average, studies that control for this variable, find more positive association, between infrastructure capital and growth of GDP.

Previous practice for robustness check has been just to omit high leverage observations (Pugh, Coric, 2008). Here, Robustness was checked by simple comparison, with robust regression available in Stata [(56)].

This robust regression, serves only for a comparison to the previously outlined. By comparison can be confirmed, that the coefficients in the two regressions have the same signs, but they differ in size, although not substantially. Robust regressions are given next, on pp.39, 40. Inverse of the standard error is positively and significantly correlated with the t-statistics (p-value =0.003). This is taken as evidence of authentic empirical effect in this literature (see Table 5, pp.39) [(57)].Positive and statistically significant intercept is taken as evidence of type I publication bias, moderator variables suggest many sources of heterogeneity , inverse of the standard error is a measure of authentic empirical effect conditional upon both, publication bias and sources of heterogeneity. The evidence of publication bias is stronger, than the evidence of authentic empirical effect in this literature. Probability of type I error when rejecting the null of insignificant variables is 0.000 in the two robust regressions.

---

[56] See Appendix 8 Robust regressions

[57] On the other hand coefficient on the squared root of the degrees of freedom is negative and insignificant i.e. authenticity of the empirical effect in question is not confirmed

Table 5 Robust regression t-stat regressed on inverse of the standard error

Dependent variable t-statistics			
	t-stat	coeff	P>|t|
inverse of the standard error	1.inv_se	0.001	0.003
endogeneity	2.endogeneity	-1.14	0.000
pooled times series cross section data	3.pool_ts_cs	0.72	0.004
foreign direct investment	4.fdi	-2.53	0.000
us studies	5.us	1.40	0.000
regional studies	6.reg_s	-0.33	0.277
transitional economies	7.trans_e	-2.56	0.000
Public and private infrastructure capital to GDP	8.pubc_priv_gdp	-0.37	0.393
convergence rate	9.con_r	-0.71	0.023
telephones per million inhabitants	10.tpminh	1.47	0.059
real exchange rate	11.rer	-1.57	0.008
government size investment and current spending	12.gsics	-2.47	0.000
average annual ratio of defence, agr,soc,health,mining expenditure to GDP	13.aardaehstcihmm_gdp	-2.04	0.000
average ratio of electricity net value	14.aroenv	-1.88	0.119
capacity utilization	15.c_util	1.09	0.200
Terms of trade	16. tot	-0.45	0.560
human capital	17.human	-0.26	0.452
budgetary deficit as percentage to GDP	18. bdp_gdp	-2.09	0.000
debt	19. debt	0.37	0.167
political and economic freedom	20.pol_efr	-0.80	0.203
openness	21.opennes	1.68	0.011
intercept	22.constant	2.80	0.000
F-test	F(21, 319) = 20.58		
Prob>F	Prob > F = 0.0000		

Source : STATA 10

Table 6 Robust regression t-statistics regressed on squared root of the degrees of freedom

	t-stat	coeff	P>|t|
squared root of the degrees of freedom	1.sqrtdf	-0.004	0.851
endogeneity	2.endogeneity	-0.81	0.001
pooled times series cross section data	3.pool_ts_cs	0.60	0.032
foreign direct investment	4.fdi	-0.66	0.172
us studies	5.us	1.75	0.000
regional studies	6.reg_s	-0.70	0.016
transitional economies	7.trans_e	-2.81	0.000
public and private infrastructure capital to GDP	8.pubc_priv_gdp	-0.86	0.049
convergence rate	9.con_r	-0.21	0.46
telephones per million inhabitants	10.tpminh	2.24	0.004
real exchange rate	11.rer	-1.51	0.017
government size investment and current spending	12.gsics	-2.16	0.000
average annual ratio of defence, agr,soc,health,mining expenditure to GDP	13.aardaehstcihmm_gdp	-1.85	0.000
average ratio of electricity net value	14.aroenv	-2.18	0.071
capacity utilization	15.c_util	1.99	0.019
human capital	16.human	-0.12	0.723
budgetary deficit as percentage to GDP	17. bdp_gdp	-1.84	0.001
political and economic freedom	18.pol_efr	-0.27	0.681
openness	19.opennes	1.40	0.04
intercept	20.constant	2.95	0.000
F-test	F(19, 326) = 20.58		
Prob>F	Prob > F = 0.0000		

Source ; STATA 10

Next, follows issue of presence of publication bias in this literature. As we said earlier, the simplest and most commonly used method to detect publication bias is an informal examination of a funnel plot. Precision can be measured in variety of ways, the most common and precise of which is the inverse of the standard error ($1/S_e$) (**Figure, 4**). The sample size or its square root also serves as a measure of precision (**Figure, 5**), (Stanley, 2005).

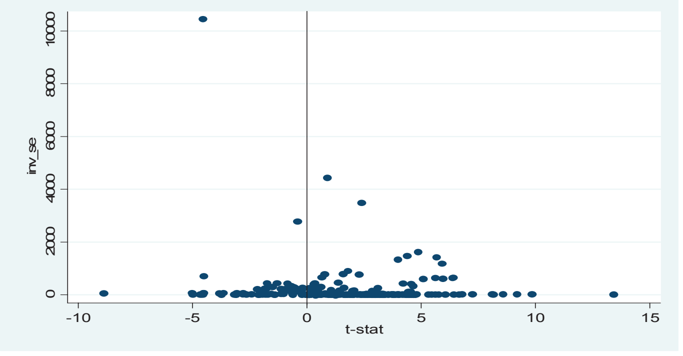

Figure 4. Funnel Plot, t-stat on inverse of standard errors

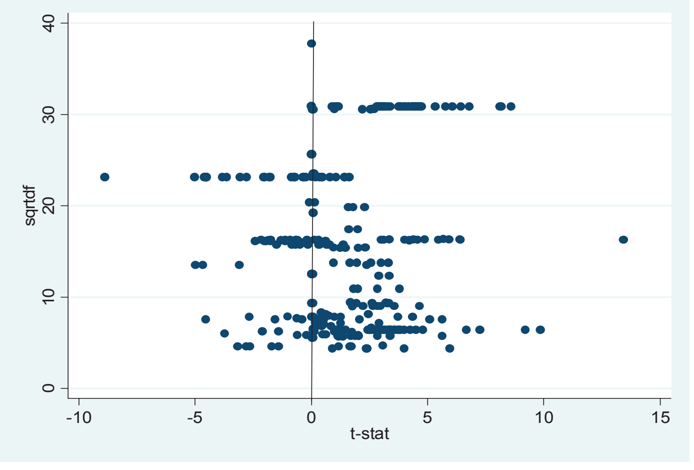

Figure 5 Funnel Plot, t-stat on squared root of the degrees of freedom

In the absence of publication selection and regardless of the magnitude of the true effect, estimates will be symmetrically around the true effect. Because small sample studies with large standard errors and less precision are at the bottom of the graph , the plot will be more spread out at the bottom than it is at the top (Stanley,2005).

However, it is the graph symmetry or asymmetry that is crucial to assessing publication bias. If the plot is overweighed on one, or another side, it is taken, as evidence of publication bias. Equating publication bias with asymmetry of a funnel graph assumes that publication selection, *a priori*, favours a particular direction (Type I selection). If alternatively, publication selection favours, statistical significance, regardless of the direction (i.e. Type II selection), then the funnel would tend to be hollow and excessively wide. Watching closely, Funnel plots, in Figures 7 and 8, there is evidence of asymmetry. Especially in **Figure 4**, where the graph is overweighted on the positive side, of the x axis (labelled- t-stat). In **Figure 5**, as well in some parts of the graph there is evidence of asymmetry and the graph is overweighted on positive side. This can be taken as evidence, that publication selection favours, a positive direction [(58)]. Next, follows twoway graph of estimated output elasticities on the inverse of the standard error

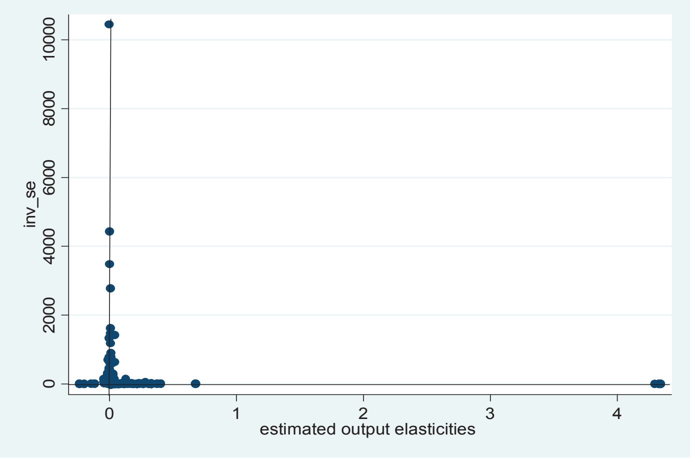

Figure 6. Funnel graph of output elasticities

[58] Generally theory predicts positive association between infrastructure capital and growth of GDP.

Only few studies report negative output elasticises (**Figure 6**) .So far we have seen an empirical literature that appears biased and highly skewed. However any visual inspection is subject to subjective interpretation. The second major limitation of funnel graphs is the assumption that there is single underlying "true effect" common to all studies (Stanley, 2005). Or in the absence of a single value for true effect, its variations are assumed to be random. Also heterogeneity across studies, different countries, and different time periods, and any asymmetric distribution of countries or time periods selected might cause the funnel's skewness. Thus publication selection needs not to be only source of asymmetry [(59)].

In the presence of either the inverse SE or the square root of the degrees of freedom, the intercept term in a MRA is a test for publication bias. In the absence of an authentic empirical effect (i.e. if the coefficient on the inverse SE - or the square root of the degrees of freedom if that is included instead - is not significantly different from zero) then the intercept measures the degree of publication bias controlling for the sources of heterogeneity represented by the moderator variables.

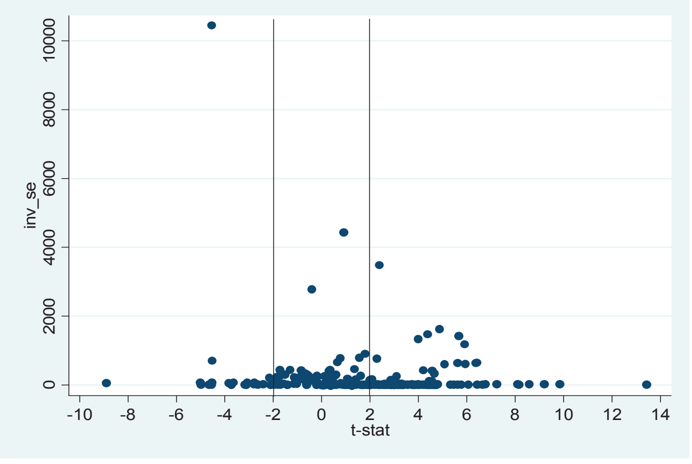

Figure 7. Galbraith plot of output elasticity t-statistics

59 There may exist different types of misspecification biases; omitted variables, models function form, different estimation techniques etc. That may induce skewing variations in funnel distribution.

Note the wide variation in the reported t-statistic on **Figure 7**. Assuming that there were, no genuine (infrastructure capital-growth effect) only 5% of the studies should report t-statistic exceeding roughly ± 2. In our MRA, **167** of **346** regressions report t-statistics **>+2** or **<-2**. The average number of regressions per study is **12.98**. Approximately 13 papers report *t-statistics* greater, in magnitude, than associated critical value of $\alpha = 0.05$. The conclusion is that in this literature there is excess variation, reflecting selection for statistical significance, or the effects of random misspecification biases. In our models, coefficient on the inverse of the standard error is negative and significant at **10%** level of significance, in Cluster robust OLS specification of the first model. Yet, given that the estimated average effect size is positive [60], the conclusion is that there is no genuine empirical effect, and since constant is positive and statistically significant, we cannot reject H_0: $\beta_0 \neq 0$ [61], therefore this is taken as evidence of publication bias.

Squared root of the degrees of freedom was included in the MRA to test for existence of authentic empirical effect in the literature (Stanley, 2005). Coefficient on the squared root of the degrees of freedom, is negative and insignificant in OLS and Cluster OLS regressions (see Table 4), and positive and insignificant in WLS and Cluster robust WLS regression (Table 4). There is no statistically significant relationship between the effect size, and squared root of the degrees of freedom (***sqrtdf*),** and that relationship does not have the same sign as the estimated average effect size. In other words there is no evidence of existence of authentic empirical effect in the literature. As noted by Card, Krueger (1995), statistical theory predicts relationship, between absolute t-statistics and inverse of standard error [62].

Next following recommendations of Stanley (2005), absolute t-statistics is regressed on inverse of standard error (see Appendix 9). This regression is summarized in **Table 7** and **Table 7** continued (diagnostics).

---

[60] See Appendix 3 estimated average t-statistics is 10.399
[61] See Table on pp. 20 for further explanations
[62] Or its instrument , squared root of the degrees of freedom (sqrtdf)

Table 7. Meta regression ; absolute t-statistics regressed on inverse of the standard error

		OLS	
Dependent variable absolute t-statistics (abst)		abst	P>|t|
Inverse of the standard error	1.inv_se	.00018	0.040
Endogeneity	2.endogeneity	-1.02	0.000
Pooled time series cross section data	3.pool_ts_cs	0.85	0.001
US studies	4.us	1.07	0.007
Regional studies	5.reg_s	-0.62	0.005
Transitional economies	6.trans_e	2.04	0.003
Public and private infrastructure capital to GDP	7.pubc_priv_gdp	-0.24	0.495
Convergence rate	8.con_r	-0.69	0.081
Telephones per million inhabitants	9.tpminh	1.98	0.016
Real exchange rate	10.rer	-1.93	0.001
Government size investment and current spending	11.gsics	0.82	0.083
Average annual ratio of defence agr, educ, health exp. to GDP	13. aardaehstc~p	-0.86	0.008
Average ratio of electricity net value	14.aroenv	-2.12	0.000
Capacity utilisation	15. c_util	2.72	0.000
Human capital	16.human	-0.42	0.149
Budgetary deficit as percentage to GDP	17. bdp_gdp	-2.48	0.040
Political and economic freedom	18.pol_efr	-1.12	0.000
Openness	19.opennes	1.45	0.029
Gini coefficient	20.gini	-3.63	0.008
International Finance corporation data	21.ifc_d	0.83	0.000
Average annual ratio of sum of export import to GDP	22.aarsei	-0.52	0.094
Official development assistance	22.oda	-2.26	0.000
Intercept	23._cons	3.13	0.000
R-squared		0.44	
Ho: model has no omitted variables- (prob of type I error is reported)		F(3, 316) = Prob > F =	1.35 0.26
Mean VIF (Variance Inflation Factor)		2.62	
F-test		F(22, 319) =	53.95
Prob>F		Prob > F =	0.0000

Source; STATA 10

Table 7 continued Diagnostic tests

Table 7 continued

Dependent Variable abst		OLS Robust standard errors coeff	P>|t|
Maximum VIF (Variance Inflation Factor)		7.97	
Mean VIF (Variance Inflation Factor)		2.62	
Ramsey RESET test using powers of the fitted values of tstat	Ho: model has no omitted variables	F(3, 316) = 1.35	0.26
Cameron & Trivedi's decomposition of Information Matrix test	Ho: homoskedasticity	170.60	0.0000
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no non normal skewness	46.51	0.0017
Cameron & Trivedi's decomposition of Information Matrix test	Ho: no non normal kurtosis	5.49	0.0191

Observing here a positive association between absolute t-statistics (***abst***), and inverse of the standard error is an additional means to confirm the authenticity of the effect in question. In the presence of the inverse of standard error, the intercept may be interpreted as a test for publication bias, and if significant measures the direction and strength of publication bias. In this case is positive and statistically significant with t-statistic > 2 (**7.50**).The last can be interpreted as evidence of type 2 publication bias [(63)].Functional form is correctly specified, probability of type 1 error is **0.26**, reported standard errors are robust**,** because of heteroscedasticity problem**.** Data set for this Meta-regression is available in Appendix 10.

[63] Publication bias that merely favours statistical significance regardless of the sign

Chapter 4

4. Conclusion

The effect of infrastructure investment on the growth of GDP has always been of interest to both economists and policy makers. The relationship has been widely studied by many authors using different techniques, designs, variable definitions and data sets. The results vary widely, so that no consensus has been reached about the sign and the significance of the public and private infrastructure capital and growth variable, which are the variables of interest in econometric studies. Yet, theory predicts a positive association between infrastructure capital and growth.

However, different specifications may give different results. Accordingly, Meta regression analysis was employed to obtain, a quantitative summary of this literature. Moreover through MRA we tried to explain how study –to- study variations can affect this relationship. To check for the robustness of the results, in addition to OLS, weighted and cluster -robust estimation, as well as testing down procedure were used. Robust estimation available in STATA was used only for comparison.

A, special feature of this MRA, is that it contains two related investigations. Firstly, because results in the literature are typically reported as constant elasticities, we investigate determinants of the size of infrastructure effect.

Secondly, we investigate the determinants of the statistical significance of the estimates reported in the literature (using the t-statistics on the variable of interest in each study as our effect size).

First, we discuss our analysis of the significance of the estimates reported in the literature.

Next, follows Table 8 and Table 8 continued, summary of outcomes for the outlined models, and conclusions. The results are from a fully specified model.

Table 8. Findings on Type I publication bias: Dependent variable (effect size): t-statistics on the variable of interest in each study

Type I publication bias (t-stat as dependent variable)	sign on the coefficient on inv_se (inverse of the standard error) and significance				
	t-stat regressed on inv_se (model 1)				
inverse of the standard error (inv_se)+control variables	OLS	Cluster robust OLS	WLS	Cluster robust WLS	robust regression for model 1
Sign on the inverse of the standard error (inv_se) and significance	-	-*	-	-	+**
Sign on the constant and significance	+***	+***	+***	+***	+***

"- "- negative sign on the variable   *- significant at 10 percent level of significance

"+"-positive sign on the variable   **-significant at 5 percent level of significance

n.a.- not available   ***- significant at 1 percent level of significance (all levels of significance)

Table 8a. Findings on Type I publication bias: Dependent variable (effect size): t-statistics on the variable of interest in each study

Type I publication bias (t-stat as dependent variable)	sign on the coefficient on sqrtdf (squared root of the degrees of freedom) and significance				
	t-stat regressed on sqrtdf (model 2)				
squared root of the degrees of freedom (sqrtdf) +control variables	OLS	Cluster robust OLS	WLS	Cluster robust WLS	robust regression for model 1
Sign on the squared root of the degrees of freedom (sqrtdf) and significance	-	-	+	+	+
Sign on the constant and significance	+***	+***	+***	+***	+***

"- "- negative sign on the variable *- significant at 10 percent level of significance

"+"-positive sign on the variable **-significant at 5 percent level of significance

n.a.- not available ***- significant at 1 percent level of significance (all levels of significance)

Table 8b. Findings on Type II publication bias: Dependent variable (effect size): absolute t-statistics on the variable of interest in each study

Type I I publication bias (absolute t-stat as dependent variable)	sign on the coefficient on inverse of the standard error (inv_se) and significance
inverse of the standard error (inv_se) +control variables	OLS
inverse of the standard error (inv_se) and significance	-**
Sign on the constant and significance	+***

"- "- negative sign on the variable *- significant at 10 percent level of significance

"+"-positive sign on the variable **-significant at 5 percent level of significance

n.a.- not available ***- significant at 1 percent level of significance (all levels of significance)

Table 8c. Findings on Type I publication bias: Dependent variable (effect size): absolute t-statistics on the variable of interest in each study

Testing type I publication bias	OLS		Cluster robust OLS		WLS		Cluster robust WLS		robust regression	
Model 1 (t-stat regressed on the inverse of standard error)	type I publication bias	authentic empirical effect	type I publication bias	authentic empirical effect	type I publication bias	No authentic empirical effect	type I publication bias	authentic empirical effect	type I publication bias	authentic empirical effect
	√	×	√	×	√	×	√	×	√	√

√- There is evidence of Type I publication bias or authentic empirical effect

×- There is no evidence of Type I publication bias or authentic empirical effect

Table 8d. Findings on Type I publication bias: Dependent variable (effect size): absolute t-statistics on the variable of interest in each study

Testing type I publication bias	OLS		Cluster robust OLS		WLS		Cluster robust WLS		robust regression	
Model 2 (t-stat regressed on the squared root of the degrees of freedom)	type I publication bias	authentic empirical effect	type I publication bias	authentic empirical effect	type I publication bias	No authentic empirical effect	type I publication bias	authentic empirical effect	type I publication bias	authentic empirical effect
	√	×	√	×	√	×	√	×	√	×

√- There is evidence of Type I publication bias or authentic empirical effect

×- There is no evidence of Type I publication bias or authentic empirical effect

Table 8e. Findings on Type II publication bias: Dependent variable (effect size): absolute t-statistics on the variable of interest in each study

Testing type II publication bias	OLS	
Model 3 (absolute t-statistics regressed on the inverse of standard error)	type II publication bias	authentic empirical effect
	√	√

√- There is evidence of Type II publication bias or authentic empirical effect

×- There is no evidence of Type I publication bias or authentic empirical effect

As can be seen from Tables, **8**, **8a**, and **8b**, regarding the signs and the level of significance of the variables are drawn conclusions which are summarized in Table **8c**, **8d**, and **8e**. Positive and statistically significant intercept in Model 1 (t-stat regressed on the inverse of standard error) and Model 2 (t-stat regressed on the squared root of the degrees of freedom), are taken as evidence of Type I publication bias in this literature. This is true when these two models are estimated using any of 5 estimation techniques, namely: OLS; Cluster robust OLS; WLS; Cluster robust WLS; and robust regression.

We have clear evidence of Type I publication bias in this literature, suggesting that theoretical expectations appear to bias reported empirical findings. These results of MRA establish that, at least to some extent, the result of simple vote counting in this literature may be misleading. Namely with respect to the growth effects of infrastructure investment, theory predicts positive association. **22** published empirical studies coded in this MRA, report positive effects while **8** are inconclusive [(64)].

Next, **167** of **346** regressions report t-statistics **>+2** or **<-2**. Of which, 141 regressions report t-statistics **>+2,** and 26 regressions report t-statistic **<-2**.This shows that in this literature, Type II publication bias is likely to be present. The positive and statistically significant intercept in Model 3 (absolute t-statistics regressed on the inverse of standard error), is taken as evidence of existence of Type II publication bias (Stanley, 2005). In Table 8e, there is evidence of Type II publication bias as well as authentic empirical effect.

The least precise estimated output elasticities tend to be positive, while the more precise estimates cluster around zero (see Figure, 9).This is consistent with findings of Type I publication bias in this literature.

Also, studies that do have public and private infrastructure capital as variable of interest, on average tend to find bigger output elasticity (see model reported in Table 3).

Next, follows our conclusions, about the existence (non-existence), of authentic empirical effect in this literature.

---

[64] See Appendix 2

A, positive and statistically significant coefficient on the inverse of the standard error, in the robust regression of model 1 is taken as evidence of authentic empirical effect. However, the other 4 estimation techniques, when applied to model 1, report negative and statistically insignificant coefficients on the inverse of standard error variable. This means an absence of authentic empirical effect (Stanley, 2005).

The mean effect size is **(+1.47)** [65], this suggests positive relationship between *infrastructure capital (public and private) and growth of GDP per capita variable.*

However this positive relationship is not robust; the average effect falls short of conventionally accepted levels of significance. The signs and the sizes of the coefficients on the variables do not differ significantly, in different specifications of the model. The authenticity of the effect in question is not confirmed. The main conclusion here is that in this literature we find both Type I publication bias(directional) and Type II publication bias(favouring statistical significance), together with an absence of authentic empirical effect.

Finally, we comment on moderator variables that reveal sources of heterogeneity in this literature.

Modelling strategy may influence estimates of infrastructure investment on growth of GDP. On average studies that do control for ***(pool_ts_cs),*** pooled time series cross section data, (***tpminh***), telephones per million inhabitants, (***c_util***) capacity utilization, and (***openness***) trade openness variables, and US studies (***us***), find more positive association between infrastructure investment and growth of GDP per capita, than the studies that control for panel data (***panel***), developed and least developed countries (***dc_ldc***), regional studies (***reg_s***), transitional economies (***trans_e***) etc.

This evidence of heterogeneity of empirical findings may be instructive for policy: first by establishing that average infrastructure capital effects on growth of GDP cannot be generalized across the countries. This is because, our moderator variables controlling for studies for the US, other developed economies, least developed economies and transitional economies, suggest markedly different growth effects of infrastructure investment among these different types of economies.

Furthermore, this MRA confirms that the positive association between infrastructure capital and growth is conditional upon the factors (variables) , in the model that help to explain why this relationship varies from, more significantly positive to less positive , conditional upon the

---

[65] See Appendix 3

explanatory variables used in the model. Furthermore, this MRA suggests that growth-promoting effects of infrastructure are less in developed and least developed countries (***dc_ldc)*** and transitional economies (***trans_e)*** than in US economy [(66)].

Meta –regression analysis does have an important limitation. If there is common systematic publication bias across the entire literature, Meta regression analysis has no way to distinguish it from the authentic empirical effect (Rose, Stanley, 2005). Next, limitation of this MRA is the number of studies that are included in the sample (30).

From 30 studies, 27 are published in refereed journals, and 3 working papers are included in the sample, for the reasons that are explained earlier [(67)].

However this MRA is made out of a sample of studies that are published for the time period from 1989 to 2008. Finally, it is recommended that this MRA to be enriched with further studies, as and when new contribution to the literature appears.

---

[66] Coefficient on us-studies (***us***) variable is positive and statistically significant (***dc_ldc***) is a benchmark while coefficient on transitional economies variable is negative and significant or insignificant.

[67] The two Aschauer (1997,1998), papers were taken into the sample because of their importance, other authors refer to those papers , and Deno, Eberts (1989), because of the alternative estimation technique(2SLS) applied, not used in other papers from the sample

Appendices

Appendix 1

1. Endogenous and Exogenous Growth Theoretical models

Two distinctive features of exogenous and endogenous growth are that, endogenous growth is depending on constant returns to scale $(\alpha + \beta = 1)$ and a rise because of capital deepening. Exogenous growth involves diminishing returns and is ultimately due to population growth, the assumption is made due that labour and population are identical which was not the case in all papers, and also technology is exogenous[68].

1.2. Endogenous Growth Models

The determination of Long-Run growth within the model, rather than by some exogenously growing variables like unexplained technological progress, is the reason for the name endogenous growth (Barro, Salla I Martin, 1995).

1.3 The AK model

The simplest property of endogenous growth models is the absence of diminishing returns to capital. The simplest version of production function without diminishing returns to scale is the AK function:

A is positive constant that reflects the technology. Output per capita is y=Ak, we know that:

$$Y = AK$$

$y = \frac{Y}{L}$ -growth rate of output per unit labour

$k = \frac{K}{L}$ -growth rate of capital per unit labour

And, the average marginal products of capital are constant at the level A>0

If we substitute $\frac{f(k)}{k} = A$ in:

[68] This is similar to spirit of Barro, 1990

Where $(n+\delta)$ term can be thought as effective depreciation rate for the capital/labour ratio, $\equiv K/L$, s is the savings rate , and γ it is used to denote a growth rate of capita variable, then we get :

$$\gamma_k = sA - (n+\delta)$$

Next the AK model can be introduced graphically:

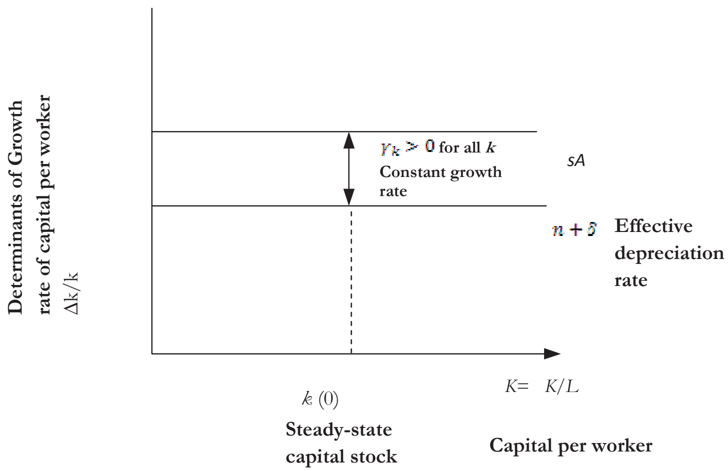

Figure 1 Economic growth with constant average product of capital (Barro, 2008)

In the AK model technology is AK, and then the savings curve is $s \cdot f(k)/k$ here for graphical presentation is straight line. If, sA $> n+\delta$, then the perpetual growth of k occurs, even without technological progress so that growth rate is higher than zero.

$$\gamma_k > 0$$

And since the two lines are parallel and constant γ_k is constant and it is independent of k. In this model k always grows at the steady-state rate, $\gamma^*_k = sA - (n+\delta)$. Since $\gamma = AK$, growth rate of output per capita also equals growth rate of capital variable, $\gamma_y = \gamma_k^*$ at every point in time. Hence, all the variables in the model grow at a constant rate given by:

$$\gamma = \gamma^* = sA - (n + \delta))$$

Also, the consumption in economy c equals to the growth rate of capital:

$$c = (1 - s)y = \gamma_k^*$$

In this model the level of consumption, a shift in some point in time to a permanently higher *s* means a lower level of c at that point but permanently higher per capita growth rate , γ^*, and after some period higher consumption. For instance government can introduce policy that raises the savings rate permanently. Similarly, if the level of technology, *A*, improves once and for all then the long run growth rate is higher. For example the elimination of governmental distortion effectively raises *A* (the level of technology) [(69)].

2. Exogenous Savings rate models (The Solow- Swan model)

There is only one commodity output as a whole, whose rate of production is designated Y. Output is produced with the help of two factors of production capital (K) and labour (L). Technological possibilities are represented by a production function (Solow, 1956):

$$Y = F(K, L)$$

Part of the output is saved and part is consumed and the rest is saved and invested. The fraction of the output saved is constant s, so that the rate of saving is, $sY(t)$, and the fraction of output that is consumed is given by 1- *sY(t)*. The community's stock of capital K, takes the form of an accumulation for the composite commodity, whose rate of input is K (t). Net investment, is just the rate of increase in this capital stock dK/dt or $\dot{K}$. Following the macroeconomic equilibrium condition demand to equal supply, which translates into claiming that investment, equals savings:

[69] High tax rates on capital income, a failure to protect property rights, and various government regulations are equivalent to poorer level of technology

The net increase in stock of physical capital at a point in time equals gross investment less depreciation:

$$\dot{K} = I - \delta K = s \cdot F(K, L) - \delta K \text{ From where we get}$$

$$\dot{K} = sY \text{ equilibrium condition}$$

Where, a dot over a variable, such as $\dot{K}$ denotes differentiation with respect to time. Next the intensive form is as follows:

$$\dot{K} / L = s \cdot f(k) - \delta k$$

$\dot{K} / L$ can be written as function of k, $\dot{k} = \frac{d(K/L)}{dt} = \dot{K}/L - nk$, where n= $\dot{L}/L$ which stands for growth of L. Next, by using these terms we get:

$$\dot{k} = s \cdot f(k) - (n + \delta) \cdot k$$

Term $(n + \delta) \cdot k$ is the effective depreciation rate for the capita/labour rate, $k \equiv K/L$.

Next, the Solow-Swan model is graphically presented:

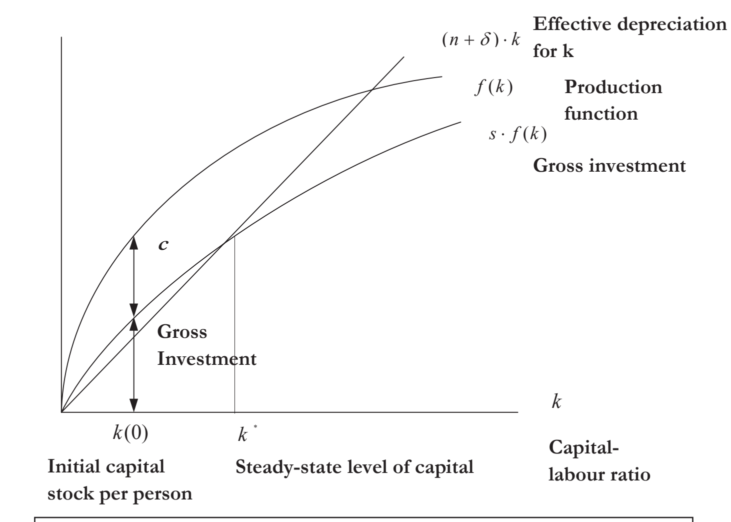

Figure 2 the Solow-Swan model

On the figure 2, the curve for gross investment, $s \cdot f(k)$ is proportional to the production function, $f(k)$.The vertical distance between $f(k)$ and $s \cdot f(k)$ is consumption. Effective depreciation for (k) is given by $(n+\delta) \cdot k$. The steady-state level k^* is determined by the intersection of the $s \cdot f(k)$, and $(n+\delta) \cdot k$ line. In following, we outline the properties of neo-classical production function [(70)].For the production function to be neoclassical must satisfy three properties:

First of all if K>0 and L>0, $F(\cdot)$ exhibits positive and diminishing marginal products for each input:

$$\frac{\partial F}{\partial K} > 0, \qquad \frac{\partial^2 F}{\partial K^2} < 0$$
$$\frac{\partial F}{\partial L} > 0, \qquad \frac{\partial^2 F}{\partial L^2} < 0$$

Second, $F(\cdot)$ exhibits constant returns to scale:

$$F(\lambda K, \lambda L) = \lambda * F(K, L) \quad \forall \lambda > 0$$

Third the marginal product of capital approaches infinity as capital or labour goes to infinity:

$$\lim_{k \to 0} (F_k) = \lim_{L \to 0} (F_L) = \infty$$
$$\lim_{K \to \infty} (F_K) = \lim_{L \to \infty} (F_L) = 0$$

These properties are called *Inada conditions*, introduced by Inada (1963), (Barro, Sala I Martin, 1995).

The condition for constant returns to scale can be written as:

$$Y = F(K, L) = L \cdot F(K/L, 1) = L \cdot f(k)$$

Where, $k \equiv \frac{K}{L}$ the capital to labour ratio, and $y - Y/L$, is growth of per capita output.

[70] Robert Solow in his 1956 paper states: "I have been deliberately neo-classical as you can get"

2.1 Steady State

Steady state is a situation in which various quantities grow at constant rates. In Solow-Swan model, the steady-state corresponds to $\dot{k} = 0$ [71]:

$$\dot{k} = s \cdot f(k) - (n + \delta) \cdot k$$

If we divide both sides by *k*, we get the expression for growth rate of capital per worker:

$$\dot{k}/k = s \cdot f(k)/k - (n + \delta)$$

Since, *s* (saving), *n* (population growth), and δ (depreciation rate) are constants in steady –state, it follows that $f(k)/k$ is constant in the steady state (Barro, Salla I Martin, 1995). Therefore, as long as *k* is finite, growth rate of capital equals zero, $\dot{k}/k = 0$, in the steady-state. Next real GDP per worker grows because of technological progress, g, and growth of capital per worker, $\Delta k / k$

$$\Delta y / y = g + a(\Delta k / k) \text{ (Barro, 2008)}$$

Knowing that growth rate of capital per worker, $\Delta k / k$, is determined in the Solow model by :

$$\Delta k / k = sA \cdot f(k)/k - s\delta - n$$

Where:

• $A \cdot f(k)/k$ is the average product of capital ; y/k
• *s* is the saving rate ;
• δ is the depreciation rate ;
• n is the population growth rate ; $n = \frac{\Delta L}{L}$

[71] Net increase in capital stock is equal to zero

Key equation (growth rate of real GDP per worker with technical progress) we get by substituting the value of growth rate of capital per worker:

$$\Delta y / y = g + a[sA \cdot f(k)/k - s\delta - n]$$

Here, technological growth is given by $g = \frac{\Delta A}{A}$. Increase in A raises the average product of capital $y/k = A \cdot f(k)/k$, for given *k*. Hence, the negative effect of rising *k* on y/*k* is offset by a positive effect from rising A. The economy will go in a situation in which these two balance. That is, *k* will increase in the long run at a constant rate, and *y*/*k* will be unchanging (Barro, 2008). That is what is called *steady-state* growth. So that the values of steady-state growth are given by:

$$(\Delta y / y)^* = (\Delta k / k)^*$$

If we substitute for $\Delta k / k$ in $\Delta y / y = g + a(\Delta k / k)$ we get:

$$(\Delta y / y)^* = g + a(\Delta y / y)^*$$

From this equation after algebraic manipulation we get the expression for growth rate positively correlated with the technological progress:

$$(\Delta y / y)^* = g/(1 - a)$$

$$(\Delta k / k)^* = g/(1 - a)$$

Since 0<a< 1 , previous equation tells us that the steady-state growth rate of real GDP per capita is greater than the rate of technological progress, g. Next we consider how technological progress affects steady-state saving. The growth rate of capital per worker, $\Delta k / k$, is again:

$$\Delta k / k = s \cdot (y/k) - s\delta - n$$

Since $(\Delta k / k)^* = g/(1-a)$ we get:

$$g/(1-a) = s \cdot (y/k) - s\delta - n$$

By rearranging the terms we get:

$$s \cdot [(y/k) - \delta] = n + g/(1-a)$$

By multiplying by *k* we determine the saving per worker, $s \cdot (y - \delta k)$, in steady-state growth:

$$s \cdot (y - \delta k) = nk + [g/(1-a)] \cdot k$$

When $g = 0$, steady-state saving per worker equals, *nk*, or the amount needed to provide growing labour force with capital to work with. Otherwise when, $g > 0$, steady-state savings includes the term $g/(1-a) \cdot k$. And since $g/(1-a) \cdot k = \Delta k / k$ we get

$$[g/(1-a)] \cdot k = (\Delta k / k) \cdot k = \Delta k$$

This term is the saving per worker needed in the steady-state to provide the increasing capital per worker (Barro, 2008).Next; in figure 3 it is shown the transition path for Capital per Worker:

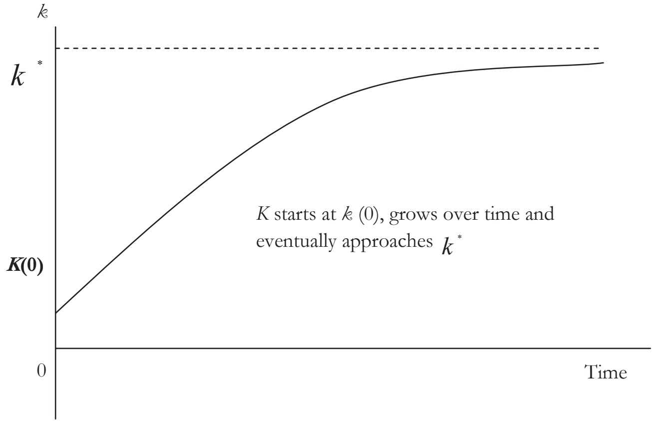

Figure 3. Transition path for Capital per Worker toward steady-state

Capital per worker starts at *k (0)* and rises over time and eventually approaches steady-state value k^*.

2.2 Initial level of technology

We follow Solow's practice, by assuming that technology grows exogenously at constant rate g:

$$\Delta A / A = g$$

• ΔA - Is the change in the level of technology
• A – is the initial level of technology
• g- is the growth of technology

The growth accounting equation again is:

$$\Delta Y / Y = \Delta A / A + a \cdot (\Delta K / K) + (1 - a) \cdot n$$

$\Delta L / L = n$	-Population growth rate
$\Delta A / A = g$	-technological growth rate

Growth rate of real GDP per worker is:

$$\Delta y / y = \Delta Y / Y - \Delta L / L$$

Growth rate of capital per worker:

$$\Delta k / k = \Delta K / K - \Delta L / L$$

By a set of algebraic manipulations we get:

$$\Delta y / y = g + a \cdot (\Delta k / k)$$

2.2 Basic Empirical framework of the theoretical model

Solow's model takes the rates of savings, population growth, and technological progress as exogenous. We assume Cobb-Douglas production function, so production function at time t is:

$$Y(t) = k(t)^{a} (A(t)L(t))^{1-a} \qquad 0 < a < 1$$

• Y	is output
• **k**	capital
• **L**	labour
• **A**	technology

$A(t)L(t)$ Grows exogenously at rate $n+g$ (population growth +technology growth):

$$L(t) = L(0)e^{nt}$$

$$A(t) = A(0)e^{gt}$$

The models assume that fraction of output, s, is invested. Next:

1. $k = K / AL$ -stock of capital per effective unit of labour
2. $y = Y / AL$ -level of output per effective unit of labour

To remember that net increase in stock of capital is:

$$\overset{*}{k}(t) = sy(t) - (n + g + \delta)K(t)$$

• $\overset{*}{k}(t)$ -net increase in the stock of physical capital
• $sy(t)$ -gross investment
• $nk(t)$ –population growth
• $gk(t)$- technological growth
• $\delta k(t)$ -depreciation

In steady state:

$$s k^{*a} = (n + g + \delta) k^{*}$$

$$k^{*} = \left[s / (n + g + \delta)\right]^{/(1-a)}$$

Or:

The steady state capital labour ratio is positively related to the savings rate and negatively to the rate of population growth. Substituting this in the Cobb-Douglas production function, and taking logs we get:

$$\ln\left[\frac{Y(t)}{L(T)}\right] = \ln A(0) + gt + \frac{a+b}{1-a-b}\ln(s_{g+p}) - \frac{a+b}{1-a-b}\ln(n + g + \delta)$$

Next, ε is country specific shock:

$$\ln A(0) = a + \varepsilon$$

The basic empirical specification is:

$$\ln(\frac{Y}{L}) = a + \frac{a+b}{1-a-b}\ln(s_{g+p}) - \frac{a+b}{1-a-b}\ln(n + g + \delta) + \varepsilon$$

1. $\ln\left(\frac{Y}{L}\right)$ - Log GDP per working age person
2. $\ln(s_k)$ -Log measure of proportionate investment (in public and private) physical

Public and private saving is equal to investment [72]. The Solow model and endogenous growth models (AK-model), are the main models tested in the literature (Cavusoglu, Tebaldi, 2006). Basic assumption here is that all countries are at their steady-state. Following MRW model transition to steady –state is given by:

$$\frac{d\ln(y(t))}{dt} = \lambda\left[\left(\ln\left(y(t)^{*}\right) - \ln(y(t))\right]$$

[72] The assumption that s and n are independent of ε implies that this equation can be estimated by OLS

• $\lambda = (n + g + \delta)(1 - a - b)$ the speed of convergence
• $y(t)$ is the actual output per effective worker
• y^* is the steady-state level of income at time t ;
• $y(0)$ is the initial level of income

This equation can be rewritten:

$$\ln(y(t)) = \left(1 - e^{-\lambda t}\right)\ln(y^*) + e^{-\lambda t}\ln(y(0))$$

Subtracting $y(0)$ from both sides we get:

$$\ln(y(t)) - \ln(y(0)) = \left(1 - e^{-\lambda t}\right)\ln(y^*) - \left(1 - e^{-\lambda t}\right)\ln(y(0))$$

By inclusion of initial level of technology in the basic empirical specification we get:

$$\ln(y(t)) - \ln(y(0)) = (1 - e^{-\lambda t})\left[\frac{a}{1-a-B}\ln(Sg) - \frac{B}{1-a-B}\ln(Sp) + \ln A(0) - \frac{a+B}{1-a-B}\ln(n+g+\delta) - \ln(y(0))\right]$$

- A(0) is the initial level of technology
- $(n + g + \delta)(1 - a - B)$ is the speed of convergence λ
- *y(0)* is the income per worker at some initial date

2.3 The augmented framework

Mankiw *et.al* (1992), find that augmenting the Solow model with human capital improves predictive performance of the model for explaining cross-country growth rates. This paper introduces human capital variable as stock variable (Yamarik, 2006). The model is:

$$\ln[y_t]-\ln[y_0]=(1-e^{-\lambda t})\ln[A_0]+gt-(1-e^{-\lambda t})\ln(y_0)+(1-e^{-\lambda t})\times\frac{a}{1-a}\ln(sk)-(1-e^{-\lambda t})\frac{a}{1-a}\ln[n+g+\delta]+(1-e^{-\lambda t})\frac{\eta}{1-a}h^{\sim *}$$

$\lambda=(n+g+\delta)(1-a-\eta)$ is the speed of convergence

• y_t is the transitional output growth rate of output per worker ;
• y_0 is the initial output growth rate per worker ;
• A_0 is the initial level of technology ;
• s_k is the investment in physical capital (public and private) in per capita terms ;
• $(n+g+\delta)$ is the break-even investment ;
• $h^{\sim *}$ is the steady state level of human capital per worker ;
• η is the human capital share ;

Appendix2

Number	Study	Number of Observations coded from the study	year of publication	Published in	sign on the coefficients on public capital estimated in the study	
					Positive	Negative
1	Aschauer -Dynamic output and employment effects of public capital	20	1997	working paper	1	0
2	Aschauer -Public capital and economics growth	24	1998	working paper	1	0
3	Aschauer -Public capital and economic growth issues on Quantity, finance ,efficiency ,	15	2000	Economic development and cultural change University of Chicago	1	0
4	Aschauer-do States optimize? Public capital and economic growth	29	2000	The Annals of regional science	1	0
5	Blanka Sanchez Robles -Infrastructure investment and growth	10	1998	Contemporary economic policy	1	1

6	Bougheas Spiros ,Demetriades Panicos , Mamuneas Theofannis,- Infrastructure , specialization and economic growth	4	2000	Canadian Journal of Economics	1	0
7	Benno Torgler ,Christof Schaltegger- Growth effects of public expenditure on state and local level	30	2006	Applied Economics	1	1
8	Le Vu Mahn Suruga Terukazi-FDI, public expenditure, and economic growth the empirical evidence for the period 1970-2002	6	2005	Applied Economics	1	1
9	"Miller James Nigel,Tsoukis Cristopher-On the optimality of public capital for long run economic growth: evidence from panel data"	12	2001	Applied Economics	1	0
10	Kalyvitis Sarantis -Public Investment rules and endogenous growth from Canada	9	2003	Scotish Journal of Political economy	1	0
11	Trish Kelly -Public expenditures and growth	20	1997	The Journal of Development Studies	1	1

12	Khan S. Moshin, Kumar S.Manmohan-Public and private investment and growth process in developing countries	19	1997	Oxford bulletin of economics and statistics	1	0
13	Fuentes M. Cesar-Infrastructure investment , convergence and regional productivity of manufacturing indutstries in Mexico(1970-1993)	9	2004	Momento Economico	1	0
14	Ahmed Abdulahi , Suardi Sandy-Sources of economic growth and technology transfer in Sub-Saharan Africa	18	2007	South African Journal of Economics	1	0
15	Denno Duffy T. Kevin , Eberts W. Randal -Public infrastructure and regional development: A simultaneous equations approach	4	1989	working paper	1	0
16	Dessus Sebastien , Herrera Remy - Public capital and growth revisited : A panel data assesment	2	2000	Economic development and cultural change University of Chicago	1	0
17	Aschauer David Alain-The Role of Public Infrastructure Capital in Mexican Economy Growth	8	1998	Economia Mexicana. Nueva Epoca,	1	0

18	Alfranca Oscar Galindo Angel Miguel - Public expenditure income distribution and Growth in OECD countries	2	2003	IAER - Polytechnic University of Catalonia and **University of Castilla-La Mancha Spain.	1	1
19	Andreas Stephan -Assesing the contribution of public capital to private production : evidence from German manufacturing sector	5	2003	International Review of Applied Economics	1	0
20	Ramirez-Public capital and labour productivity in Chile	5	2000	Contemporary economic policy	1	0
21	Ramirez D. Miguel -A panel unit root and panel cointegration test of the complementary hypothesis in Mexican case:1960-2001	6	2007	International Atlantic Economic Society	1	0
22	Agarwal Sumit Anusua Data - Telecomunications and economic growth: a panel data approach	14 6	2004	Applied Economics	1	0
23	De Mello Luiz Jr.-Public finance, government spending and economic growth : the case of local governments in Brazil	6	2002	Applied Economics	1	0

24	Tanninen Hannu-Income inequality , government expenditures and growth	12	1999	Applied Economics	1	1
25	Roler Hendrik Lars , Waverman Leonard -Telecommunication infrastructure and economic development	3	2001	Journal of Economic Literature	1	0
26	Paramo Gonzales Manuel Jose - Convergence across Spanish regions : New evidence of the effect of Public investment	35	2003	The Review of Regional Studies	1	0
27	Lin Shuanglin ,Shunfeng Song -Urban economic growth in China: Theory and evidence	4	2002	Urban Studies	0	1
28	Gosh ,Paya -On public investment Real exchange rate and growth : some empirical evidence form USA and UK	3	2003	The Manchester School Blackwell Publishing	1	1

29	Ramirez Nazmi -Public investment and economic growth in Latin America : an empirical test	2	2003	Review of development economics	1	0
30	Voss, Otto, Milbourne -Public investment and economic growth	18	2003	Applied economics	1	0

Appendix 3

Meta-analysis of the effect size

ACOOEL= AVERAGE EFFECT SIZE

$$t - stat = \frac{averagetcooel}{\sigma^2_{ACOOEL}}$$

ACOOEL=1.467307 $\sigma^2_{ACOOEL} = 2.62475$

Hence

$$t = \frac{1.467307}{\frac{2.62475}{\sqrt{346}}} = \frac{1.467307}{0.1411} = 10.399$$ Non –zero t-statistic

Chi-sq test statistic $\left(\chi^2\right) = (n-2)\frac{\hat{\sigma}_{ACOOEL}}{\sigma_{ACOOEL}}$

Where n=346; $\sigma^2_{ACOOEL} = 2.62475$; $\sigma_{ACOOEL} = 1$;

Hence, $\chi^2 = 902.914$ Excess Variation

And for the 344 degrees of freedom, the two-tailed P value is less than 0.0001.

For practical purpose there is zero probability of making type I error.

Appendix 4

Summary Statistics for all the variables

Variable	Obs	Mean	Std. Dev.	Min	Max
tstat	346	1.467307	2.62475	-8.89	13.43103
cooel	342	1.251358	10.86528	-20.394	155.22
df	346	340.5983	349.6019	19	1426
endogeneity	346	.2456647	.4311041	0	1
pool_ts_cs	346	.5462428	.498578	0	1
panel	346	.4537572	.498578	0	1
hausmann	346	.0115607	.1070522	0	1
robust	346	.3699422	.4834879	0	1
gdp_egr	346	.3988439	.4903697	0	1
fdi	346	.0433526	.2039445	0	1
us	346	.1820809	.3864701	0	1
dc_ldc	346	.8323699	.3740784	0	1
reg_s	346	.283237	.4512231	0	1
trans_e	346	.0346821	.1832383	0	1
nl_ogs	346	.0578035	.2337094	0	1
pubc_priv_~p	346	.9450867	.2281409	0	1
tax_l	346	.0520231	.2223953	0	1
opw	346	.0346821	.1832383	0	1
unem_r	346	.2803468	.4498192	0	1
con_r	346	.7398844	.4393328	0	1
debt	346	.2138728	.4106319	0	1
efficiency	346	.0924855	.2901297	0	1
opennes	346	.0953757	.2941586	0	1
pol_efr	346	.1069364	.3094799	0	1

```
pol_inst |       346    .0115607    .1070522          0          1
-------------+--------------------------------------------------------
      pop_gr |       346    .2254335    .4184727          0          1
         bmp |       346    .0086705    .0928453          0          1
      tpminh |       346    .0231214    .1505067          0          1
pvd_rds_pm~q |       346    .0057803    .0759183          0          1
       gsics |       346    .0867052    .2818101          0          1
-------------+--------------------------------------------------------
         agg |       346    .0751445    .2640062          0          1
         oda |       346     .017341    .1307277          0          1
         rer |       346    .0231214    .1505067          0          1
aardaehstc~p |       346    .2456647    .4311041          0          1
         thm |       346    .0115607    .1070522          0          1
-------------+--------------------------------------------------------
      aarsei |       346    .0578035    .2337094          0          1
       ifc_d |       346    .0086705    .0928453          0          1
     bdp_gdp |       346    .0549133    .2281409          0          1
      aroenv |       346    .0057803    .0759183          0          1
         inf |       346     .017341    .1307277          0          1
-------------+--------------------------------------------------------
        gcon |       346    .0751445    .2640062          0          1
       ncspw |       346    .0057803    .0759183          0          1
       union |       346    .0115607    .1070522          0          1
        gini |       346    .0404624    .1973265          0          1
      c_util |       346    .0144509    .1195128          0          1
-------------+--------------------------------------------------------
           l |       346    .0433526    .2039445          0          1
         tot |       346    .0144509    .1195128          0          1
     nfapgdp |       346    .0086705    .0928453          0          1
       human |       346    .1300578    .3368542          0          1
 se_complete |       342    1.782864    5.506661         -3   51.31841
ldf |       346    5.136125    1.288807   2.944439   7.26262
```

```
-------------+--------------------------------------------------------
      sqrtdf |        346    15.85947    9.451649   4.358899   37.76242
      inv_se |        342    149.1614    684.9555        -21   10441.55
        abst |        346    2.221225    2.024946       .003   13.43103
       labst |        346   -.0127174     1.71854  -5.809143   2.597568
```

Data Appendix

1. **tstat** – is the chosen effect size in the meta regression
2. **cooel**-is the coefficient on the output elasticity ; or growth of gdp in log terms;
3. **df-** are the reported or calculated degrees of freedom in the reported studies;
4. **endogeneity**- is a combined variable from the econometrics techniques that control for the endogeneity: 2SLS, 3 SLS , IV techniques, Binary variable takes values of 1 or 0
5. **pool_ts-cs**-are pooled , time series, cross-section data also to control for different estimation methods applied takes value of 1 , when one of these techniques is applied or zero if not.
6. **panel**- binary variable taking value 1 if it is applied one of the panel estimation techniques or zero if not
7. **hausman** – is binary variables that control for exogeneity in the studies taking value of 1 if it is present or zero if not
8. **robust**- is the binary variable to check for robustness in the models , also binary variable taking values of 1 or 0
9. **gdp_egr**- is growth of gdp and employment ; binary variable taking values of 1 or 0
10. **fdi**- is the binary variable to control for presence of foreign direct investment variable in the models
11. **us**-is binary variable to control 1 for us studies or 0 for non-us
12. **dc_ldc**- is binary variable that control 1 for sample of developed or least developed countries or zero for other
13. **reg_s**- is binary variable that control 1 for regional studies or 0 otherwise
14. **trans_e**- is binary variable that control 1 for sample of transitional economies or 0 otherwise

15. **nl_ogs**- is binary variable to control for presence of natural logarithm of output of goods and services in the regression (1) or 0 otherwise
16. **pubc_priv_gdp-** is the variable of interest taking values of 1 to control for presence of public or private infrastructure capita in the study ;
17. **tax_l-** is binary variable to control for presence of tax liabilities in the model 1 or if not 0
18. **opw** – output per worker is binary variable to control 1 if the variable is present in the model or zero otherwise ;
19. **unem_r**- is the unemployment rate variable to control 1 if the unemployment rate is present in the model or zero otherwise;
20. **con_r** – is the variable controlling 1 for the presence of the convergence rate variable in the model or zero otherwise;
21. **debt**- is binary variable to control 1 for the debt variable in the model or zero otherwise
22. **eff**- is the binary variable to control for the efficiency if it is in the i model 1 or if not 0
23. **openness**- is the binary variable to control for one country trade openness 1 or otherwise 0 ;
24. **pol_efr-** is binary variable to control 1 for one country political and economic freedom or zero otherwise;
25. **pol_inst-** is binary variable to control for one country political instability 1 or zero otherwise;
26. **pop_gr-** is the binary variable to control 1 for population growth or zero otherwise
27. **bmp-** is black market premium binary variable to control 1 or zero for presence in the models of this variable
28. **tpminh-** is binary variable to control for presence of telephones per million inhabitants in the regressions in the models
29. **pvd_rds_pm~q-** paved roads per million kilometres squared , is binary moderator variable to control for paved roads per million kilometres squared 1 or zero otherwise
30. **gsics**- is binary variable to control for government size-investment and current spending ;
31. **agg**- is binary variable to control for agglomeration in the model 1 , or zero otherwise;
32. **oda**- is binary variable to control for official development assistance in the model ;
33. **rer-** is the real exchange rate binary variable to control 1 or zero for real exchange rate variable
34. **aardaehstc~**p- is binary variable to control for presence of annual ratio of defence, education, health, social and transport and communication expenditures
35. **thm**- is binary variable to control 1 for total expenditures in housing, mining , manufacturing
36. **aarsei**- is binary variable to control 1 for average annual ratio of sum of export and import or zero otherwise
37. **ifc_d-** is binary variable to control 1 for international finance corporation data or zero otherwise
38. **bdp_gdp-** is binary variable to control 1 for budgetary deficit as percentage to gdp
39. **aroenv-** is binary variable to control 1 for average ratio of electricity net value
40. **inf-** is binary variable to control 1 for inflation or zero otherwise

41. **gcon**-is binary variable to control for government consumption 1 , or zero otherwise
42. **ncspw**-is binary variable to control for net capital stock per worker 1 or zero otherwise
43. **union-** is binary variable to control 1 for union membership or zero otherwise
44. **gini**-is binary variable to control 1 for gini coefficient or zero otherwise,
45. **c-util**-is binary variable to control 1 for capacity utilization or zero otherwise
46. **l**- is binary variable to control 1 for labour zero otherwise
47. **tot**- is binary variable to control 1 for terms of trade or zero otherwise ;
48. **nfagdp**-is binary variable to control 1 for net foreign assets as percentage to GDP
49. **human** – is binary variable to control 1 for human capital zero otherwise
50. **se_complete**-is continuous standard error variable
51. **sqrtdf**- represents squared root of the degrees of freedom
52. **inv_se-** represents inverse of the standard error
53. **abst-** represents absolute value of the t-statistics
54. **labst-** log absolute tstatistics value
55. **ldf-** is log of the degrees of freedom

Appendix 5

Regressions numbered

```
1. tstat on inverse of standard error regression

Linear regression                                  Number of obs =     342
                                                   F( 19,   322) =   27.83
                                                   Prob > F      =  0.0000
                                                   R-squared     =  0.5159
                                                   Root MSE      =  1.8875

------------------------------------------------------------------------------
             |               Robust
       tstat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

inv_se	-.0003598	.0002388	-1.51	0.133	-.0008297	.0001101
endogeneity	-.4449656	.2787815	-1.60	0.111	-.9934288	.1034975
pool_ts_cs	.5347137	.2708855	1.97	0.049	.0017848	1.067643
fdi	-.8672389	.8106586	-1.07	0.286	-2.462095	.7276173
us	1.305047	.3845779	3.39	0.001	.5484439	2.061649
reg_s	-.9989718	.2783574	-3.59	0.000	-1.546601	-.4513428
trans_e	-3.123426	.8097735	-3.86	0.000	-4.716541	-1.530311
pubc_priv_~p	-.302389	.4173138	-0.72	0.469	-1.123395	.5186168
con_r	-.4113595	.3897584	-1.06	0.292	-1.178154	.3554351
tpminh	2.252968	1.027518	2.19	0.029	.2314706	4.274465
rer	-2.287636	.7189092	-3.18	0.002	-3.701988	-.8732837
gsics	-2.844416	.5714523	-4.98	0.000	-3.968668	-1.720165
aardaehstc~p	-2.004549	.300668	-6.67	0.000	-2.59607	-1.413027
aroenv	-1.752361	.4469871	-3.92	0.000	-2.631745	-.8729769
c_util	3.730348	1.877042	1.99	0.048	.0375335	7.423162
human	-.3927407	.2437439	-1.61	0.108	-.8722724	.086791
bdp_gdp	-1.908044	.3134274	-6.09	0.000	-2.524668	-1.29142
pol_efr	-.6466301	.5701714	-1.13	0.258	-1.768362	.4751015
opennes	1.597231	.6483273	2.46	0.014	.3217389	2.872723
_cons	2.890603	.5064054	5.71	0.000	1.894322	3.886884

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat
       Ho:  model has no omitted variables
                 F(3, 319) =      1.69
                  Prob > F =      0.1681
```

```
. estat vif

    Variable |       VIF       1/VIF  
-------------+----------------------
     opennes |      5.26    0.190253
     pol_efr |      5.04    0.198556
       reg_s |      2.44    0.410640
       gsics |      2.34    0.428023
       con_r |      2.10    0.477104
  pool_ts_cs |      2.02    0.495694
aardaehstc~p |      1.92    0.519507
      tpminh |      1.90    0.526162
       human |      1.86    0.538736
          us |      1.77    0.565620
     trans_e |      1.71    0.583996
     bdp_gdp |      1.48    0.673698
pubc_priv_~p |      1.41    0.709825
      c_util |      1.40    0.712885
 endogeneity |      1.32    0.757654
         fdi |      1.31    0.761340
      aroenv |      1.18    0.848520
      inv_se |      1.14    0.877352
         rer |      1.08    0.922253
-------------+----------------------
    Mean VIF |      2.04
```

```
estat imtest

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |     153.77     68    0.0000
            Skewness |      45.89     19    0.0005
            Kurtosis |       5.51      1    0.0189
---------------------+-----------------------------
               Total |     205.17     88    0.0000
```

2.Cluster Robust OLS regression tstat on the inverse of the standard errors

```
Linear regression                                      Number of obs =     342
                                                       F( 15,    29) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.5159
                                                       Root MSE      =  1.8875

                                (Std. Err. adjusted for 30 clusters in author)
------------------------------------------------------------------------------
             |               Robust
       tstat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inv_se |  -.0003598   .0002223    -1.62   0.116    -.0008144    .0000948
 endogeneity |  -.4449656   .4619248    -0.96   0.343    -1.389708    .4997767
```

```
  pool_ts_cs |   .5347137    .407476     1.31   0.200    -.2986683    1.368096
         fdi |  -.8672389   1.386603    -0.63   0.537    -3.703161    1.968684
          us |   1.305047   .5132512     2.54   0.017     .2553301    2.354763
       reg_s |  -.9989718   .5830043    -1.71   0.097    -2.191349    .1934059
     trans_e |  -3.123426   .9484509    -3.29   0.003    -5.063226   -1.183626
pubc_priv_~p |   -.302389   .5515979    -0.55   0.588    -1.430533    .8257554
       con_r |  -.4113595   .6038108    -0.68   0.501    -1.646291    .8235724
      tpminh |   2.252968   1.499071     1.50   0.144    -.8129756    5.318911
         rer |  -2.287636   .9312333    -2.46   0.020    -4.192222   -.3830498
       gsics |  -2.844416   .6340565    -4.49   0.000    -4.141208   -1.547625
aardaehstc~p |  -2.004549   .5490851    -3.65   0.001    -3.127554   -.8815435
      aroenv |  -1.752361   .6726048    -2.61   0.014    -3.127992   -.3767296
      c_util |   3.730348   1.131502     3.30   0.003     1.416167    6.044529
       human |  -.3927407   .4028562    -0.97   0.338    -1.216674    .4311927
     bdp_gdp |  -1.908044   .5209134    -3.66   0.001    -2.973431   -.8426561
     pol_efr |  -.6466301   .7912939    -0.82   0.420    -2.265008    .9717477
     opennes |   1.597231   .9279998     1.72   0.096    -.3007414    3.495204
       _cons |   2.890603   .8401138     3.44   0.002     1.172378    4.608829
------------------------------------------------------------------------------

. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat
       Ho:  model has no omitted variables
                 F(3, 319) =      1.69
                  Prob > F =      0.1681

. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
     opennes |      5.26    0.190253
     pol_efr |      5.04    0.198556
       reg_s |      2.44    0.410640
```

gsics	2.34	0.428023
con_r	2.10	0.477104
pool_ts_cs	2.02	0.495694
aardaehstc~p	1.92	0.519507
tpminh	1.90	0.526162
human	1.86	0.538736
us	1.77	0.565620
trans_e	1.71	0.583996
bdp_gdp	1.48	0.673698
pubc_priv_~p	1.41	0.709825
c_util	1.40	0.712885
endogeneity	1.32	0.757654
fdi	1.31	0.761340
aroenv	1.18	0.848520
inv_se	1.14	0.877352
rer	1.08	0.922253
Mean VIF	2.04	

3. WLS regression tstat on the inverse of the standard error

(sum of wgt is 2.9765e+01)

```
Linear regression                                      Number of obs =     342
                                                       F( 17,   324) =   22.38
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.4228
                                                       Root MSE      =  2.0306

------------------------------------------------------------------------------
             |               Robust
       tstat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

inv_se	-.0002342	.0003179	-0.74	0.462	-.0008597	.0003913
endogeneity	-.533268	.3541329	-1.51	0.133	-1.229958	.1634222
pool_ts_cs	-.0849652	.3323258	-0.26	0.798	-.738754	.5688237
fdi	-1.404881	.7949423	-1.77	0.078	-2.968781	.1590196
us	.8988377	.3872589	2.32	0.021	.1369784	1.660697
reg_s	-1.275619	.3382519	-3.77	0.000	-1.941067	-.6101721
trans_e	-3.409361	.8724149	-3.91	0.000	-5.125674	-1.693048
pubc_priv_~p	-.3688632	.5512369	-0.67	0.504	-1.453319	.7155921
con_r	-.0036121	.433742	-0.01	0.993	-.8569183	.8496941
rer	-1.828221	.930662	-1.96	0.050	-3.659124	.0026828
gsics	-3.229472	.6381662	-5.06	0.000	-4.484944	-1.973999
aardaehstc~p	-1.948089	.3351927	-5.81	0.000	-2.607518	-1.28866
aroenv	-1.537291	.6172468	-2.49	0.013	-2.751609	-.322974
c_util	4.038907	1.801732	2.24	0.026	.494336	7.583478
bdp_gdp	-1.85536	.365519	-5.08	0.000	-2.57445	-1.13627
pol_efr	-1.00463	.5502423	-1.83	0.069	-2.087128	.077869
opennes	2.197244	.5486017	4.01	0.000	1.117973	3.276516
_cons	3.208215	.5466514	5.87	0.000	2.13278	4.283649

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat
       Ho:  model has no omitted variables
                F(3, 321) =      1.82
                 Prob > F =      0.1431

. estat vif
```

Variable	VIF	1/VIF
opennes	3.48	0.287444
pol_efr	3.48	0.287652
reg_s	2.05	0.487465

```
aardaehstc~p |      1.97    0.508514
pubc_priv_~p |      1.90    0.525294
      c_util |      1.65    0.606994
       con_r |      1.57    0.636885
         fdi |      1.53    0.655482
       gsics |      1.45    0.691565
  pool_ts_cs |      1.43    0.697975
          us |      1.42    0.705513
     trans_e |      1.36    0.737227
     bdp_gdp |      1.27    0.787493
 endogeneity |      1.25    0.800048
      aroenv |      1.22    0.817240
         rer |      1.17    0.857099
      inv_se |      1.14    0.881002
-------------+----------------------
    Mean VIF |      1.72
```

4.Cluster Robust WSL regression tstat on the inverse of the standard error

```
(sum of wgt is   2.9765e+01)

Linear regression                                      Number of obs =     342
                                                       F( 13,    29) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.4228
                                                       Root MSE      =  2.0306

                                   (Std. Err. adjusted for 30 clusters in author)
------------------------------------------------------------------------------
```

tstat	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
inv_se	-.0002342	.0002927	-0.80	0.430	-.0008329	.0003645
endogeneity	-.533268	.6037997	-0.88	0.384	-1.768177	.7016411
pool_ts_cs	-.0849652	.5365155	-0.16	0.875	-1.182263	1.012332
fdi	-1.404881	1.146612	-1.23	0.230	-3.749966	.9402046
us	.8988377	.6104689	1.47	0.152	-.3497113	2.147387
reg_s	-1.275619	.6901672	-1.85	0.075	-2.68717	.1359309
trans_e	-3.409361	.8263873	-4.13	0.000	-5.099513	-1.71921
pubc_priv_~p	-.3688632	.6818733	-0.54	0.593	-1.763451	1.025724
con_r	-.0036121	.6494681	-0.01	0.996	-1.331923	1.324699
rer	-1.828221	1.02439	-1.78	0.085	-3.923333	.2668918
gsics	-3.229472	.8056196	-4.01	0.000	-4.877149	-1.581795
aardaehstc~p	-1.948089	.5902633	-3.30	0.003	-3.155313	-.7408652
aroenv	-1.537291	.8326945	-1.85	0.075	-3.240343	.1657601
c_util	4.038907	1.182827	3.41	0.002	1.619755	6.458059
bdp_gdp	-1.85536	.5387321	-3.44	0.002	-2.957191	-.7535292
pol_efr	-1.00463	.7461043	-1.35	0.189	-2.530584	.5213249
opennes	2.197244	.713076	3.08	0.004	.7388403	3.655649
_cons	3.208215	.8694272	3.69	0.001	1.430036	4.986393

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat
       Ho:  model has no omitted variables
                 F(3, 321) =      1.82
                  Prob > F =      0.1431
```

```
. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
     opennes |      3.48    0.287444
     pol_efr |      3.48    0.287652
       reg_s |      2.05    0.487465
aardaehstc~p |      1.97    0.508514
pubc_priv_~p |      1.90    0.525294
      c_util |      1.65    0.606994
       con_r |      1.57    0.636885
         fdi |      1.53    0.655482
       gsics |      1.45    0.691565
  pool_ts_cs |      1.43    0.697975
          us |      1.42    0.705513
     trans_e |      1.36    0.737227
     bdp_gdp |      1.27    0.787493
 endogeneity |      1.25    0.800048
      aroenv |      1.22    0.817240
         rer |      1.17    0.857099
      inv_se |      1.14    0.881002
-------------+----------------------
    Mean VIF |      1.72
```

Appendix 6

```
5.Wls regression cooel on inv_se

(sum of wgt is   5.1058e+04)

Linear regression                                      Number of obs =     338
                                                       F( 22,   315) =   24.26
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.0948
                                                       Root MSE      =  .16233
```

cooel	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
inv_se	-9.36e-07	8.65e-07	-1.08	0.280	-2.64e-06	7.65e-07
endogeneity	-.0330201	.0216188	-1.53	0.128	-.0755555	.0095154
pool_ts_cs	.0129345	.0263278	0.49	0.624	-.0388661	.064735
fdi	-.0223246	.0125265	-1.78	0.076	-.0469708	.0023216
us	.0760676	.0401062	1.90	0.059	-.0028423	.1549776
reg_s	-.0127789	.0133532	-0.96	0.339	-.0390516	.0134939
trans_e	4.297834	7.342411	0.59	0.559	-10.14853	18.7442
pubc_priv_~p	.1975286	.0427256	4.62	0.000	.113465	.2815922
con_r	-.2122071	.0414067	-5.12	0.000	-.2936758	-.1307383
rer	-.0327671	.0594054	-0.55	0.582	-.1496486	.0841143
gsics	-.0277314	.0278004	-1.00	0.319	-.0824294	.0269665
aardaehstc~p	-.0447559	.0231204	-1.94	0.054	-.0902457	.0007339
aroenv	.2752526	.0498425	5.52	0.000	.1771863	.3733189
c_util	.4246811	.0790638	5.37	0.000	.2691212	.5802409
bdp_gdp	.0378924	.043618	0.87	0.386	-.0479271	.1237118
debt	.0293332	.0119281	2.46	0.014	.0058643	.052802
efficiency	.0886068	.0333519	2.66	0.008	.0229861	.1542275
opennes	-.0326664	.0231207	-1.41	0.159	-.0781569	.0128242
pol_efr	.0211264	.0452637	0.47	0.641	-.0679311	.1101839
pop_gr	-.0125989	.012534	-1.01	0.316	-.0372598	.0120621
bmp	.0064224	.0072199	0.89	0.374	-.0077829	.0206278
pvd_rds_pm~q	-.0458706	.0616578	-0.74	0.457	-.1671837	.0754425
_cons	.0552851	.0244269	2.26	0.024	.0072246	.1033455

. estat ovtest

Ramsey RESET test using powers of the fitted values of cooel

Ho: model has no omitted variables

F(3, 312) = 2.60

Prob > F = 0.0523

```
. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
  pool_ts_cs |     13.48    0.074170
 endogeneity |     11.79    0.084819
         fdi |      9.01    0.110948
      pop_gr |      7.03    0.142293
         bmp |      6.33    0.157870
       con_r |      5.56    0.179911
       gsics |      5.52    0.181210
pubc_priv_~p |      5.32    0.187878
aardaehstc~p |      5.05    0.198003
      inv_se |      4.26    0.234578
       reg_s |      3.45    0.289700
     pol_efr |      3.01    0.331767
     opennes |      2.91    0.343617
         rer |      2.66    0.375242
          us |      2.10    0.477023
  efficiency |      1.78    0.562253
pvd_rds_pm~q |      1.51    0.664423
        debt |      1.30    0.771820
      c_util |      1.18    0.846614
     bdp_gdp |      1.03    0.971293
     trans_e |      1.01    0.994924
      aroenv |      1.00    0.997212
-------------+----------------------
    Mean VIF |      4.38
```

Appendix 7

6.Regression reported tstat on the squared root of the degrees of freedom (sqrtdf)

```
      Source |       SS       df       MS              Number of obs =     346
-------------+------------------------------           F( 19,   326) =   17.76
       Model |  1208.85282    19  63.6238328           Prob > F      =  0.0000
    Residual |  1167.96033   326  3.58270041           R-squared     =  0.5086
-------------+------------------------------           Adj R-squared =  0.4800
       Total |  2376.81316   345   6.8893135           Root MSE      =  1.8928

------------------------------------------------------------------------------
       tstat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      sqrtdf |   .0062392   .0240913     0.26   0.796    -.0411548    .0536332
 endogeneity |  -.4800473   .2915239    -1.65   0.101    -1.053553    .0934582
  pool_ts_cs |   .5961876   .3360645     1.77   0.077    -.0649412    1.257316
         fdi |  -1.074933   .5845335    -1.84   0.067    -2.224867    .0750006
          us |   1.276972   .4589995     2.78   0.006     .3739973    2.179947
       reg_s |  -.8849224   .3478223    -2.54   0.011    -1.569182    -.200663
     trans_e |  -3.026443   .7517552    -4.03   0.000    -4.505347    -1.54754
pubc_priv_~p |  -.3186284   .5281875    -0.60   0.547    -1.357715    .7204578
       con_r |  -.4489263   .3370998    -1.33   0.184    -1.112092    .2142392
      tpminh |   2.013845   .9281976     2.17   0.031     .1878318    3.839858
         rer |  -2.183081   .7581071    -2.88   0.004     -3.67448   -.6916813
       gsics |  -2.946587   .5893557    -5.00   0.000    -4.106008   -1.787167
aardaehstc~p |  -2.011445   .3285581    -6.12   0.000    -2.657807   -1.365084
      aroenv |  -1.768145   1.456312    -1.21   0.226    -4.633101    1.096812
      c_util |   3.606018   1.016748     3.55   0.000     1.605802    5.606234
       human |  -.3742643   .4144327    -0.90   0.367    -1.189564    .4410356
     bdp_gdp |  -2.000695   .6508771    -3.07   0.002    -3.281144   -.7202453
     pol_efr |  -.6826679   .8035706    -0.85   0.396    -2.263506    .8981704
     opennes |   1.632549    .822908     1.98   0.048     .0136687    3.251429
       _cons |   2.751091   .7678131     3.58   0.000     1.240597    4.261585
------------------------------------------------------------------------------
```

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat
       Ho:  model has no omitted variables
                 F(3, 323) =      1.21
                  Prob > F =      0.3055

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of tstat

         chi2(1)      =     0.09
         Prob > chi2  =   0.7591

. estat imtest

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |     117.14     65    0.0001
            Skewness |      35.91     19    0.0108
            Kurtosis |       6.97      1    0.0083
---------------------+-----------------------------
               Total |     160.02     85    0.0000
---------------------------------------------------
```

7.Reported regression tstat on the squared root of the degrees of freedom Cluster OLS

```
Linear regression                                      Number of obs =     346
                                                       F( 15,    29) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.5086
                                                       Root MSE      =  1.8928

                                (Std. Err. adjusted for 30 clusters in author)
------------------------------------------------------------------------------
             |               Robust
       tstat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      sqrtdf |   .0062392   .0323191     0.19   0.848    -.0598608    .0723392
 endogeneity |  -.4800473   .3912285    -1.23   0.230      -1.2802    .3201048
  pool_ts_cs |   .5961876   .4763423     1.25   0.221    -.3780418    1.570417
         fdi |  -1.074933   1.167679    -0.92   0.365    -3.463104    1.313238
          us |   1.276972   .6278241     2.03   0.051    -.0070725    2.561017
       reg_s |  -.8849224   .4916967    -1.80   0.082    -1.890555    .1207102
     trans_e |  -3.026443   .9874649    -3.06   0.005    -5.046036   -1.006851
pubc_priv~p |  -.3186284   .5048419    -0.63   0.533    -1.351146    .7138892
       con_r |  -.4489263   .5582939    -0.80   0.428    -1.590766     .692913
      tpminh |   2.013845   1.337351     1.51   0.143    -.7213452    4.749035
         rer |  -2.183081   1.033211    -2.11   0.043    -4.296235   -.0699263
       gsics |  -2.946587   .6775257    -4.35   0.000    -4.332283   -1.560892
aardaehstc~p |  -2.011445   .5646102    -3.56   0.001    -3.166203    -.856688
      aroenv |  -1.768145   .6782928    -2.61   0.014    -3.155409   -.3808801
      c_util |   3.606018   1.070586     3.37   0.002     1.416423    5.795613
       human |  -.3742643   .3917438    -0.96   0.347     -1.17547    .4269418
     bdp_gdp |  -2.000695   .7143598    -2.80   0.009    -3.461724   -.5396647
     pol_efr |  -.6826679   .9698287    -0.70   0.487     -2.66619    1.300855
     opennes |   1.632549   .9737397     1.68   0.104    -.3589724     3.62407
       _cons |   2.751091   .9936082     2.77   0.010     .7189341    4.783248
------------------------------------------------------------------------------
```

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat
       Ho:  model has no omitted variables
                 F(3, 323) =      1.21
                  Prob > F =      0.3055

. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
     pol_efr |      5.96    0.167911
     opennes |      5.64    0.177225
      sqrtdf |      4.99    0.200288
          us |      3.03    0.330016
  pool_ts_cs |      2.70    0.369896
       gsics |      2.66    0.376464
       reg_s |      2.37    0.421594
     bdp_gdp |      2.12    0.470964
       con_r |      2.11    0.473464
aardaehstc~p |      1.93    0.517610
      tpminh |      1.88    0.532107
       human |      1.88    0.532843
     trans_e |      1.83    0.547275
 endogeneity |      1.52    0.657474
      c_util |      1.42    0.703291
pubc_priv_~p |      1.40    0.715169
         fdi |      1.37    0.730716
         rer |      1.25    0.797662
      aroenv |      1.18    0.849550
-------------+----------------------
    Mean VIF |      2.49
.
```

8.Reported WLS (weighted least squares) regression tstat on the squared root of the degrees of freedom

(sum of wgt is 3.0015e+01)

Linear regression

Number of obs	= 346
F(19, 326)	= 18.82
Prob > F	= 0.0000
R-squared	= 0.4321
Root MSE	= 2.0137

tstat	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
sqrtdf	.0084154	.0263947	0.32	0.750	-.0435101	.0603408
endogeneity	-.3982995	.337555	-1.18	0.239	-1.062361	.2657616
pool_ts_cs	.0732388	.3826854	0.19	0.848	-.6796057	.8260834
fdi	-1.588353	.7869271	-2.02	0.044	-3.136449	-.0402567
us	.8091707	.4632566	1.75	0.082	-.1021789	1.72052
reg_s	-1.070164	.2907766	-3.68	0.000	-1.642199	-.4981286
trans_e	-3.45726	.86756	-3.99	0.000	-5.163982	-1.750537
pubc_priv_~p	-.3486129	.5254113	-0.66	0.507	-1.382237	.6850117
con_r	-.0389664	.4482878	-0.09	0.931	-.9208685	.8429357
tpminh	1.887669	.9360759	2.02	0.045	.0461576	3.729181
rer	-1.795981	.9425321	-1.91	0.058	-3.650194	.0582316
gsics	-3.407566	.6933433	-4.91	0.000	-4.771558	-2.043575
aardaehstc~p	-2.025123	.3714192	-5.45	0.000	-2.755804	-1.294442
aroenv	-1.727915	.6196143	-2.79	0.006	-2.946862	-.508968
c_util	3.768374	1.812274	2.08	0.038	.2031471	7.333601
human	-.8774927	.3903169	-2.25	0.025	-1.64535	-.109635
bdp_gdp	-1.891462	.6034629	-3.13	0.002	-3.078635	-.7042895
pol_efr	-.0768732	.7130313	-0.11	0.914	-1.479596	1.32585
opennes	1.384073	.6653886	2.08	0.038	.0750758	2.69307
_cons	2.956101	.7019418	4.21	0.000	1.575194	4.337009

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat
       Ho:  model has no omitted variables
                 F(3, 323) =      0.94
                  Prob > F =      0.4212

. estat vif

    Variable |       VIF       1/VIF
-------------+----------------------
     pol_efr |      5.54    0.180544
     opennes |      4.52    0.221379
      sqrtdf |      3.34    0.299648
aardaehstc~p |      2.31    0.432276
      tpminh |      2.18    0.459731
  pool_ts_cs |      2.14    0.466844
       reg_s |      2.01    0.496599
       human |      1.99    0.502534
pubc_priv_~p |      1.90    0.525955
       con_r |      1.87    0.534232
         fdi |      1.67    0.597068
      c_util |      1.66    0.602409
 endogeneity |      1.63    0.614752
          us |      1.62    0.617514
     trans_e |      1.62    0.618611
       gsics |      1.60    0.623246
         rer |      1.59    0.630735
     bdp_gdp |      1.57    0.637854
      aroenv |      1.23    0.810432
-------------+----------------------
    Mean VIF |      2.21
```

9.Reported Cluster robust WLS (weighted least squares) regression

```
(sum of wgt is   3.0015e+01)

Linear regression                                      Number of obs =     346

                                                       F( 15,    29) =       .

                                                       Prob > F      =       .

                                                       R-squared     =  0.4321

                                                       Root MSE      =  2.0137

                                (Std. Err. adjusted for 30 clusters in author)

------------------------------------------------------------------------------

             |               Robust

       tstat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]

-------------+----------------------------------------------------------------

      sqrtdf |   .0084154   .0351038     0.24   0.812    -.0633799    .0802106

 endogeneity |  -.3982995   .4027645    -0.99   0.331    -1.222045    .4254464

  pool_ts_cs |   .0732388   .6079289     0.12   0.905    -1.170115    1.316593

         fdi |  -1.588353    1.06915    -1.49   0.148    -3.775009    .5983035

          us |   .8091707   .6171278     1.31   0.200    -.4529974    2.071339

       reg_s |  -1.070164   .5190042    -2.06   0.048    -2.131647   -.0086812

     trans_e |   -3.45726   .9200073    -3.76   0.001    -5.338886   -1.575634

 pubc_priv_~p |  -.3486129   .6561054    -0.53   0.599    -1.690499    .9932733

       con_r |  -.0389664   .5778776    -0.07   0.947    -1.220859    1.142926

      tpminh |   1.887669   1.492259     1.26   0.216    -1.164343    4.939681

         rer |  -1.795981   1.042384    -1.72   0.096    -3.927897    .3359342

       gsics |  -3.407566   .7552123    -4.51   0.000    -4.952149   -1.862984

aardaehstc~p |  -2.025123    .593197    -3.41   0.002    -3.238347   -.8118993

      aroenv |  -1.727915   .8111994    -2.13   0.042    -3.387004   -.0688258

      c_util |   3.768374   1.071398     3.52   0.001      1.57712    5.959628

       human |  -.8774927   .5913783    -1.48   0.149    -2.086997    .3320118

     bdp_gdp |  -1.891462   .8487856    -2.23   0.034    -3.627424   -.1555009

     pol_efr |  -.0768732   1.039942    -0.07   0.942    -2.203793    2.050047

     opennes |   1.384073   .8664999     1.60   0.121    -.3881181    3.156264

       _cons |   2.956101   1.135291     2.60   0.014     .6341697    5.278033

------------------------------------------------------------------------------
```

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of tstat

       Ho:  model has no omitted variables

                 F(3, 323) =      0.94

                  Prob > F =      0.4212

. estat vif


    Variable |       VIF       1/VIF

-------------+----------------------

     pol_efr |      5.54    0.180544

     opennes |      4.52    0.221379

      sqrtdf |      3.34    0.299648

aardaehstc~p |      2.31    0.432276

      tpminh |      2.18    0.459731

  pool_ts_cs |      2.14    0.466844

       reg_s |      2.01    0.496599

       human |      1.99    0.502534

pubc_priv_~p |      1.90    0.525955

       con_r |      1.87    0.534232

         fdi |      1.67    0.597068

      c_util |      1.66    0.602409

 endogeneity |      1.63    0.614752

          us |      1.62    0.617514

     trans_e |      1.62    0.618611

       gsics |      1.60    0.623246

         rer |      1.59    0.630735

     bdp_gdp |      1.57    0.637854

      aroenv |      1.23    0.810432

-------------+----------------------

    Mean VIF |      2.21

.
```

Appendix 8 Robust regression

10.Robust regression tstat on inverse of standard errors

```
   Huber iteration 1:  maximum difference in weights = .77304676
   Huber iteration 2:  maximum difference in weights = .39657213
   Huber iteration 3:  maximum difference in weights = .06259606
   Huber iteration 4:  maximum difference in weights = .05050272
   Huber iteration 5:  maximum difference in weights = .01186529
Biweight iteration 6:  maximum difference in weights = .28879477
Biweight iteration 7:  maximum difference in weights = .10658277
Biweight iteration 8:  maximum difference in weights = .04744959
Biweight iteration 9:  maximum difference in weights = .04464589
Biweight iteration 10:  maximum difference in weights = .01297509
Biweight iteration 11:  maximum difference in weights = .01019903
Biweight iteration 12:  maximum difference in weights = .00432532

Robust regression                                     Number of obs =     341
                                                      F( 21,   319) =   20.58
                                                      Prob > F      =  0.0000

------------------------------------------------------------------------------
       tstat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inv_se |   .0007548   .0002565     2.94   0.003     .0002502    .0012594
 endogeneity |  -1.141084   .2374988    -4.80   0.000    -1.608345   -.6738217
  pool_ts_cs |   .7189871   .2498564     2.88   0.004     .2274125    1.210562
         fdi |  -2.527361   .5213741    -4.85   0.000    -3.553127   -1.501594
          us |   1.404437   .3019267     4.65   0.000     .8104177    1.998456
       reg_s |  -.3256002     .29931    -1.09   0.277    -.9144711    .2632708
     trans_e |   -2.55841   .6294054    -4.06   0.000     -3.79672     -1.3201
```

```
pubc_priv_~p |  -.3739564   .4373763    -0.85   0.393    -1.234463    .4865502

       con_r |  -.7083558   .3099407    -2.29   0.023    -1.318142   -.0985697

      tpminh |   1.474815   .7787043     1.89   0.059    -.0572298     3.00686

         rer |  -1.565164   .5835883    -2.68   0.008    -2.713332   -.4169957

       gsics |  -2.470506   .4711829    -5.24   0.000    -3.397524   -1.543487

aardaehstc~p |  -2.038862   .2751065    -7.41   0.000    -2.580115    -1.49761

      aroenv |  -1.878189    1.20164    -1.56   0.119     -4.24233    .4859528

      c_util |   1.091506   .8507019     1.28   0.200    -.5821887    2.765202

         tot |  -.4504604   .7713261    -0.58   0.560    -1.967989    1.067068

       human |  -.2552418   .3390985    -0.75   0.452    -.9223939    .4119103

     bdp_gdp |  -2.092194   .4585505    -4.56   0.000     -2.99436   -1.190029

        debt |   .3675766   .2652474     1.39   0.167    -.1542787    .8894319

     pol_efr |  -.8040386   .6299526    -1.28   0.203    -2.043425     .435348

     opennes |   1.681345   .6570631     2.56   0.011     .3886199    2.974069

       _cons |   2.803401   .5278978     5.31   0.000       1.7648    3.842003
------------------------------------------------------------------------------
```

11.robust regression tstat on the squared root of the degrees of freedom

```
Huber iteration 1:  maximum difference in weights = .77553522

   Huber iteration 2:  maximum difference in weights = .34984479

   Huber iteration 3:  maximum difference in weights = .08729588

   Huber iteration 4:  maximum difference in weights = .02358305

Biweight iteration 5:  maximum difference in weights = .2795044

Biweight iteration 6:  maximum difference in weights = .06439346

Biweight iteration 7:  maximum difference in weights = .0458036

Biweight iteration 8:  maximum difference in weights = .02190516

Biweight iteration 9:  maximum difference in weights = .01596948

Biweight iteration 10:  maximum difference in weights = .01153384

Biweight iteration 11:  maximum difference in weights = .00954208


Robust regression                                     Number of obs =     346

                                                      F( 19,   326) =   21.10

                                                      Prob > F      =  0.0000
```

tstat	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
sqrtdf	-.003748	.0199132	-0.19	0.851	-.0429227	.0354267
endogeneity	-.8103701	.2409662	-3.36	0.001	-1.284415	-.3363252
pool_ts_cs	.5987753	.2777823	2.16	0.032	.0523033	1.145247
fdi	-.6616684	.4831603	-1.37	0.172	-1.612174	.2888373
us	1.746081	.3793971	4.60	0.000	.9997054	2.492457
reg_s	-.6993641	.2875009	-2.43	0.016	-1.264955	-.1337729
trans_e	-2.807242	.6213814	-4.52	0.000	-4.029666	-1.584819
pubc_priv_~p	-.8642081	.4365862	-1.98	0.049	-1.72309	-.0053263
con_r	-.2059036	.278638	-0.74	0.460	-.7540591	.3422518
tpminh	2.239209	.7672242	2.92	0.004	.7298739	3.748544
rer	-1.50683	.6266318	-2.40	0.017	-2.739582	-.2740773
gsics	-2.159945	.4871462	-4.43	0.000	-3.118292	-1.201598
aardaehstc~p	-1.846194	.2715776	-6.80	0.000	-2.380459	-1.311928
aroenv	-2.181212	1.20375	-1.81	0.071	-4.549311	.1868866
c_util	1.989196	.840418	2.37	0.019	.3358686	3.642522
human	-.1214401	.3425593	-0.35	0.723	-.7953459	.5524658
bdp_gdp	-1.835479	.5379982	-3.41	0.001	-2.893865	-.7770926
pol_efr	-.2733413	.6642107	-0.41	0.681	-1.580021	1.033339
opennes	1.403826	.6801945	2.06	0.040	.0657013	2.741951
_cons	2.953758	.6346545	4.65	0.000	1.705222	4.202293

Appendix 9

12.Linear regression absolute t statistics on inverse of the standadrd errors

```
Linear regression                                      Number of obs =     342
                                                       F( 22,   319) =   53.95
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.4416
                                                       Root MSE      =  1.5657
------------------------------------------------------------------------------
             |               Robust
        abst |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inv_se |   .0001826   .0000887     2.06   0.040     8.02e-06    .0003572
 endogeneity |    -1.0171   .2491138    -4.08   0.000    -1.507214   -.5269868
  pool_ts_cs |   .8462187   .2421289     3.49   0.001     .3698473     1.32259
          us |   1.067734   .3952085     2.70   0.007     .2901898    1.845279
       reg_s |  -.6161472   .2153836    -2.86   0.005    -1.039899   -.1923954
     trans_e |   2.044246   .6863724     2.98   0.003     .6938572    3.394634
pubc_priv_~p |  -.2385194   .3493689    -0.68   0.495    -.9258776    .4488389
       con_r |  -.6902263   .3942299    -1.75   0.081    -1.465845    .0853928
      tpminh |   1.979935   .8197796     2.42   0.016     .3670771    3.592792
         rer |  -1.932367   .5907922    -3.27   0.001    -3.094708   -.7700253
       gsics |   .8119997   .4675995     1.74   0.083    -.1079688    1.731968
aardaehstc~p |  -.8557868    .215163    -3.98   0.000    -1.279105   -.4324691
      aroenv |  -2.124992   .5348661    -3.97   0.000    -3.177303   -1.072681
      c_util |   2.724444   1.883721     1.45   0.149    -.9816423     6.43053
       human |  -.4149617   .2009333    -2.07   0.040    -.8102836   -.0196398
     bdp_gdp |  -2.485341   .2793368    -8.90   0.000    -3.034916   -1.935766
     pol_efr |  -1.124097   .5120615    -2.20   0.029    -2.131542   -.1166531
     opennes |   1.445548   .5385161     2.68   0.008     .3860562     2.50504
        gini |  -3.628828   .4609188    -7.87   0.000    -4.535653   -2.722003
       ifc_d |   .8278597   .4925856     1.68   0.094    -.1412671    1.796987
      aarsei |   -.519191   .4007484    -1.30   0.196    -1.307635    .2692529
```

```
         oda |  -2.259687   .4755619    -4.75   0.000    -3.195321   -1.324053
       _cons |   3.133625   .4176467     7.50   0.000     2.311935    3.955315
------------------------------------------------------------------------------
. estat imtest

Cameron & Trivedi's decomposition of IM-test

---------------------------------------------------
              Source |       chi2     df      p
---------------------+-----------------------------
  Heteroskedasticity |     170.60     71    0.0000
            Skewness |      46.51     22    0.0017
            Kurtosis |       5.49      1    0.0191
---------------------+-----------------------------
               Total |     222.60     94    0.0000
---------------------------------------------------

    Variable |       VIF       1/VIF
-------------+----------------------
     trans_e |      7.97    0.125424
        gini |      7.35    0.136141
     opennes |      5.29    0.188893
     pol_efr |      5.24    0.190925
       reg_s |      2.54    0.393647
       gsics |      2.51    0.397786
aardaehstc~p |      2.49    0.402147
  pool_ts_cs |      2.42    0.413367
       con_r |      2.36    0.422993
          us |      1.95    0.511691
      tpminh |      1.90    0.525370
       human |      1.89    0.528787
      aarsei |      1.74    0.574764
pubc_priv_~p |      1.56    0.642597
     bdp_gdp |      1.53    0.654049
      c_util |      1.49    0.672260
```

```
         oda |      1.45    0.687764
 endogeneity |      1.43    0.698177
       ifc_d |      1.20    0.830817
      aroenv |      1.17    0.856967
      inv_se |      1.09    0.914189
         rer |      1.09    0.915449
-------------+----------------------
    Mean VIF |      2.62

. estat ovtest

Ramsey RESET test using powers of the fitted values of abst
       Ho:  model has no omitted variables
                 F(3, 316) =      1.35
                  Prob > F =      0.2577

.
```

References:

1. Aschauer , Alan, David (1997) , ***Dynamic Output and Employment Effects of public Capital***, Working Paper,
2. Aschauer , Alan, David (1998), ***Public Capital and Economic Growth: Issues on Quantity , Equity, and Finance*** ,Working Paper
3. Aschauer , Alan, David (2000), ***Public Capital and Economic Growth: Issues on Quantity , Equity, and Finance*** , University of Chicago
4. Aschauer , Alan, David (1999), ***Do states optimize? Public Capital and Economic Growth***, The Annals of Regional Science
5. Aschauer , Alan, David (1998), ***The Role of Public Infrastructure Capital in Mexican Economic Growth***, Economia Mexicana
6. Akerlof , A. George , Dickens ,T. Wiliam , Perry, L. George (1996), ***The Macroeconomics of Low Inflation***, Brooking Papers on Economic Activity
7. Andreas, Stephan, (2003), ***Assessing the Contribution of Public Capital to Private Production: evidence from the German manufacturing sector*** , International Review of Applied Economics
8. Agarwal, Sumit , Datta , Anusua, (2004), ***Telecommunications and Economic Growth**: **a Panel Data Approach***, Applied Economics
9. Alfranca, Oscar , Galindo, Angel, Miguel, (2003), ***Public Expenditure, Income Distribution, and Growth in OECD Countries***, IAER, VOL.9 NO.2
10. Alexander, J. Robert, W.(1997), ***Inflation and Economic Growth : evidence from a Growth Equation***, Applied Economics (29)
11. Bougheas, Spiros, Demetriades, Panicos, O, Mamuenas, P, Theofanis, (2000) ***Infrastructure Specialization and Economic Growth***, Canadian journal of Economics, Vol.33 No.2

12. Barro, J. Robert (1990), ***Government Spending in a Simple Model of Endogenous Growth***, Journal of Political Economy
13. Barro, J. Robert, X. Sala-i-Martin (1995), ***Economic Growth***, New York: McGraw-Hill
14. Barro,J.Robert (2008) , ***Macroeconomics a Modern Approach*** Thompson , South-Western, Harvard University
15. Baier, L,Scott, Dwyer, P.Gerald, tamura, Robert, (2006), ***How important are capital and total factor Productivity for Economic Growth*** ? , Economic Inquiry, Vol.44 No.1
16. Button, Kenneth,(1998), ***Infrastructure investment Endogenous Growth, and Economic Convergence***, The Annals of Regional Science ,32:145
17. Cabale, Jordi , Santos, M, Manuel, (1993), ***On Endogenous Growth with Physical and Human Capital***, Journal of Political Economy, Vol.101.No.6
18. Crafts, Nicholas, ***Productivity Growth Reconsidered*** , University of Warvick
19. Card, David, Krieger, B, Alan,(2001), ***Time Series Minimum-Wage Studies :A Meta Analysis***, American Economic Association
20. Cavusoglu , Nevin, Tebaldi, Edinaldo (2006), ***Evaluating Growth Theories and their empirical support : An assessment of convergence hypothesis*** , Journal of Economic Methodology
21. Copas J, Jackson D. ***A bound for publication bias based on the fraction of unpublished studies***. Biometrics 2004; 60(1): 146-53.
22. Copas J,Henmi Masayuki ,(2007), ***Confidence Intervals and P-values for Meta-Analysis with Publication Bias***, Biometrics, 63
23. Denno, Duffy, T. Kevin, Eberts, W. Randal, (1989) , ***Public Infrastructure and Regional Economic Development*** , Working Paper,8909
24. Dessus, Sebastien , Herrera, Remy(2000), ***Public Capital and growth Revisited: A panel Data Approach*** , The University of Chicago

25. Dobson, Stephen , Ramlogan Carlyn , Strobl, Eric , (2006) ***Why do rates of β-convergence differ? A Meta-regression analysis***, Scottish Journal of Political Economy, Vol.53 No.2
26. Eakin-Holtz, Douglas,(1993), ***Solow and the states: Capital Accumulation, Productivity, and Economic Growth***, National Tax Journal,Vol.XLVI,No.4
27. Fuentes, M. Cesar (2003), ***Infrastructure Investment, Convergence, and Regional Productivity of Manufacturing Industries in Mexico(1970-1993)***,Momento Economico
28. Fourie, Johan, (2006), ***Economic Infrastructure : A Review of Definitions Theory, and Empirics***, South African Journal of Economics Vol.74:3
29. Forbes, J.Kristin (2000***), A Reassessment of the Relationship Between Inequality and Economic Growth***, The American Economic Review
30. Fisher,H. Walter,Turnovsky , J. Stephen (1998), ***Public Investment , Congestion and Private Capital Accumulation*** , The Economic Journal
31. Ghosh, Sugata, Mourmouras A. Iannis , Pal Sarmistha, Paya Ivan, (2003), ***On Public Investment the Real Exchange Rate and Growth: Some Empirical Evidence from UK and USA*** ,The Manchester School Vol.71 No.3
32. Gokal , Vikesh , Hanif , Subrina (2004), ***Relationship between inflation and economic growth***, Reserve bank of Fiji, Suva
33. Gramlich, M. Edward, (1994) ***Infrastructure Investment : A Review Essay***, Journal of Economic Literature, Vol.XXXII
34. Ghali , H. Khalifa, (1998), ***Government Size and Economic Growth: Evidence from a Multivariate Co integration Analysis***, Applied Economics, 31
35. Ghobadian , Abby , Husband, Tom, (1990) , ***Measuring Total Productivity Using Production Functions***, Int.J.Prod. Res Vol.28 No.8
36. Guillo, Dolores, Maria (1999) ***On Terms of Trade and capital Accumulation*** , Review of International Economics, 7(2)

37. Gorg, Holger,Eric Strobl , (2001), Multinational Companies and Productivity Spillovers : A Meta Analysis , The Economic Journal , 111
38. Gemmell , Norman , (1996) , ***Evaluating the Impacts of human capital stocks and accumulation on Economic Growth : Some New Evidence*** , Oxford Bulletin of Economics and Statistics
39. Gutema , Paulos , Bekele , Mekonnen , (2004), ***Does Schooling Promote Economic Growth ?*** , African Development Bank
40. Haan , De, Jacob, Siermann,J.L.Klemens (1996), ***Political Instability, Freedom and Economic Growth:Some Further Evidence*** , The University of Chicago
41. Hedges, V. Larry, Olkin, Ingram (1985), ***Statistical Methods for Meta-Analysis***, Academic Press Inc.
42. Islam, Nazrul (1998), ***Growth Empirics :A Panel Data Approach-A Reply*** , The Quarterly Journal of Economics
43. Jimenez, Salinas , Mar,Del,Maria (2003), ***Efficiency and TFP Growth in the Spanish Regions: The Role of Human and Public Capital***, Growth and Change, Vol.34 No.2
44. Jimenez, Salinas, M.M. (2003), ***Technological Change Efficiency Gains and Capital Accumulation in Labour productivity growth and Convergence, : an Application to Spanish Regions***, Applied Economics 35
45. Kalyvitis, Sarantis, (2003), ***Public Investment and Endogenous Growth with Empirical Evidence from Canada*** , Scottish Journal of Political Economy Vol.50
46. Kelly, Trish (1997), ***Public Expenditures and Growth***, Journal of Development Studies, Vol.34 No.1
47. Khan, S. Moshin , Kumar, S. Manmohan, (1997), ***Public and Private Investment and Growth Process in Developing Countries***, Oxford Bulletin of Economics and Statistics,59
48. Klenov , J. Peter , Clare Rodriduez Andres, ***The Neoclassical Revival in Growth Economics : has it gone too far?*** , University of Chicago

49. Kotorri,Mrika (2006), ***The effects of Concentration and Efficiency on Performance : A Meta-Regression Analysis***, Master dissertation, Staffordshire University

50. Kulinskaya, Elena / Morgenthaler, Stephan / Staudte, Robert G.(2008), ***A guide to calibrating and combining statistical evidence Wiley Series in Probability and Statistics***, Auflage

51. Le Vu Manh, Suruga Terukazu,(2005), ***Foreign Direct Investment, Public Expenditure and Economic Growth: The Empirical Evidence for Period 1970-2001***, Applied Economics Letters, 12

52. Lin, Shuanglin,(2000) ***, Government Debt and Economic Growth in an Overlapping Generations Model***, Southern Economics Journal 66(3)

53. Lin, Shuanglin, Song , Shungfeng (2002), ***Urban Economic Growth in China: Theory and Evidence*** , Urban Studies, Vol.39 No. 12

54. Lucas, E. Robert(1988), ***On the mechanics of Economic Development***, Journal of Monetary Economics

55. Maddala, G.S. (2001), ***Introduction to Econometrics***, University of Florida and Ohio university , MacMillan publishing company, 2nd edition

56. Mankiw, Romer, Weil (1992) ***A Contribution to the Empirics of Economic Growth***,The quarterly Journal of Economics

57. Milbourne, R.,Otto G, Voss,G. (2003) ***Public Investment and Economic Growth***, Applied Economics , 2003

58. Miller, James,Nigel , Tsoukis Cristopher, (2001), On the optimality for Public Capital for long run economic Growth: evidence from panel data ,Applied Economics

59. Merikas Anna , (2000), ***Trade Openness and Economic Growth Revisited***, the Journal of Applied Business Research

60. Mello De, R. Luiz (2002), ***Public Finance ,government spending and Economic Growth :the Case of local governments in Brazil,*** Applied Economics (34)

61. Mcdaniel , A. Michael, Rothotein, R. Hamah, Whetz,L.Debuah,(2006), ***Publication Bias :A case Study of Four Vendors***, Personnel Psychology,

62. Paramo Gonzales Manuel Jose ,Martinez Diego, (2003), ***Convergence Across Spanish Regions: New Evidence on the Effect of Public Investment***, The Review of Regional Studies, Vol.33 No.2

63. Palma, De Andre, Lindsey, Robin (2000), ***Private toll roads: Competition under various ownership regimes***, Annals of regional science 34:13-35

64. Piras, Romano , (2001), ***Government Spending Composition in an Endogenous Growth model with congestion***, Metroeconomica , 52:1

65. Polin, Robert, Zhu Andong, (2006***), Inflation and Economic Growth: a Cross-Country non-linear analysis*** , Journal of Post Keynesian Economics Vol.28 No.4

66. Peletier, D. Ben , (1998) , ***Terms of Trade Effects on Endogenous Growth Rates in LDCs*** , Oxford development Studies, Vol.26, No.3

67. Pugh, Geoff, Coric , Bruno, (2008), ***The effects of exchange rate variability on international trade : A meta-regression analysis***, Applied Economics ,1-14

68. Robles, Sanchez, B lanca (1998), ***Infrastructure Investment and growth :Some Empirical Evidence*** , Contemporary Economic Policy Vol.XVI

69. Ramirez, D. Miguel, Nazmi, Nader (2003), P***ublic Investment and Economic Grwoth in Latin America :an Empirical test,*** Review of Development Economics 7(1)

70. Roler, Hendrik, Lars , Waverman , Leonard(2001), ***Telecommunications Infrastructure and Economic Developmen***t: ***A Simultaneous Approach*** , The American Economic Review

71. Rose, K. Andrew, Stanley, T.D.,(2005), ***A Meta-Analysis of the Effect of Common Currencies on International Trade***, Journal of Economic Surveys, Vol.19 No.3

72. Ramirez, D. Miguel (2000), ***Public Capital Formation and Labor Productivity Growth in Chile*** , Contemporary Economic Policy, Vol.18 No.2

73. Ramirez, D. Miguel(2007) ***A Panel Unit Root and Panel Cointegration Testof the Complementary Hypothesis in the Mexican case: 1960-2001 ,*** Economic Journal, (35)

74. Ram ,Rati ,(2001), ***Government size and Economic Growth: A New Framework and Some Evidence from Cross –Section and Time- Series data*** , The American Economic Review

75. Robert, M. Solow (1956) ***"A Contribution to the Theory of Economic Growth"*** Quarterly Journal of Economics. Vol. 70 (1) pp. 65-94.

76. Stata corp. (2007), ***STATA base reference manual***, Q-Z, Release 10,A Stata press publication, StataCorp LP,College Station, Texas

77. Stanley, T.D. (2005), ***Beyond Publication Bias***, Journal of Economic Surveys , Vol.19, No.3

78. Stanley, T.D. , (2008) , ***Meta-Regression Methods for Detecting and Estimating Empirical Effects in the Presence of Publication Selection***, Oxford Bulletin of Economics and Statistics , 70,1

79. Stanley, T.D., Jarrell, B. Stephen, (1989), ***Meta-Regresssion analysis: A Quantitative Method of Literature Surveys***, Blackwell Publishing

80. Schaltegger, A. Cristoph, Torgler Benno, (2006), ***Growth effects of public expenditure on the state and local level:evidence from a sample of rich governments***, Applied Economics 38

81. Tanninen , Hannu (1999), ***Income Inequality , government expenditures and growth***, Applied Economics , 31

82. Tharakan , Joe , (1999) , ***Economic Growth and exchange rate uncertainty***, Applied Economics , 31

83. Yamarik Steven, (2006) , ***Solow and the states : New evidence*** ,Regional Studies , Vol.40 No.6

84. Wooldridge, Jeffrey , (2002), Introductory Econometrics A Modern Approach, Thomson