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The Potential Impact of Asian Infrastructure Investment Bank on economic growth in Asian Developing Countries: Opportunities and Challenges

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Abstract

The newly-established Asian Infrastructure Investment Bank (AIIB) has aroused public attention and comments in the whole 2014. However, researchers and economists have never reached the consensus on the economic impact of AIIB on Asian developing countries. The thesis aims to find out the potential role of AIIB in promoting economic growth in Asian developing countries through empirical research and its potential limitations and challenges that might occur in its later development path. The thesis emphasizes on the five countries with highest demand for aid which nearly account for 90% of the whole demand in Asia in infrastructure and observes the long run relationship between infrastructure development, official development aid (ODA) and economic growth through historical data of the macroeconomics variables in five countries in past two decades. In the research, autoregressive distributed lagged (ARDL) approach to cointegration is applied to help find out the long run coefficients between interested variables. Also, Granger causality test is employed to determine the causality between infrastructure development and economic growth.

The empirical results imply that AIIB has a potentially positive role in promoting economic growth in Asian developing countries because at least one interested variable, namely, infrastructure development or ODA, has significant long-run relationship with economic growth in five countries. Based on the findings, suggestions have made to aid allocation criteria of AIIB, though it has not been announced yet using Performance-Based Assessment (PBA). At the same time, the thesis concludes the potential challenges facing AIIB in the last part of the thesis and personal views of possible solutions are pointed out accordingly.

Key Words

AIIB, Infrastructure, official development aid, economic growth

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1. Introduction

Infrastructure development is commonly believed to be a vital source of GDP growth. Its significance in economic development was first strongly argued in World Development Report (World Bank, 1994) and is repeated in World Bank Growth Commission Report (World Bank, 2008). It's now widely accepted that developing countries and regions with high population density will to the large extent reduce poverty and meet rapidly changing needs of people if they can deliver better facilities in the swiftest and effective manner.

In the past decades, multilateral international organizations, such as International Monetary Fund (IMF), World Bank, Asian Development Bank (ADB) have achieved some success to offer financial and technical assistance to developing countries around the world and spared enduring efforts to help them fight poverty by providing resources, sharing knowledge and facilitating regional cooperation. Despite that great contributions have been dedicated by World Bank and ADB with lending capital ranging from environmental protection to gender equality, some critics argue that they are slow and bureaucratic, deter investment and build constraints for lending. Notably, they still can neither address Asia's growing infrastructure needs nor close the funding gap. According to estimations from ADB, Asian regions will need as much as 8 trillion US dollars to address critical infrastructure needs by 2020 in order to maintain economic growth.

Under this circumstance, the China-led Asian Infrastructure Investment Bank (AIIB), a multilateral lending institution with initial 50 billion US dollars and expected 57 member countries so far was established to offer long-term financing for transportation, telecommunications and energy projects of Asian developing countries, along with other corresponding development institutions in China, including Silk Road Fund, New development Bank.

Although the existence of AIIB might facilitate the regional development economic growth, it will still confront skepticism and challenges, such as government corruptions, and vulnerable law system etc. Possible solutions and its future path should also be figured out to support the sustainable development of AIIB and positive effects on its member countries.

1.1 Research objectives

The thesis mainly aims to investigate the role of Asian Infrastructure Investment Bank in promoting economic growth in Asian developing countries. The long term relationship between infrastructure development, ODA and economic growth is the key interest of this objective. Besides the research of the role of AIIB, including its economic and political objectives, the thesis also focuses on the differences between AIIB and other International Organizations, such as ADB and World Bank.

The second objective of the thesis is to give suggestions to aid allocation criteria for AIIB on the basis of traditional performance based assessment widely used by other multilateral lending institutions. Final parts of the thesis target to find out challenges and skepticism AIIB faces and possible solutions to the challenges.

1.2 Research Questions

The main purpose of the thesis is to provide possible answers to the following research questions.

1) Under which circumstances are China-led AIIB established and what goals should it achieve after core business being fully implemented.

2) What is the potential role of AIIB to promote economic growth on the basis of understanding aid-growth and infrastructure-growth relationship.

3) What stands AIIB out compared with other international organizations

4) What suggestions and modifications can be made to aid allocation criteria for AIIB

5) What are the potential challenges to efficiently implement AIIB lending and daily affairs

2. Literature Review

2.1 Literature Findings on aid-growth relationship

Over the past decades, great efforts have been made to identify empirically the impact of multilateral lending on economic growth and development (aid-growth relationships) in developing countries. This section aims to discuss the three aspects in aid-growth relationship relevant to the thesis, namely, statistical difficulties in estimation, the relationship between multilateral lending and key macroeconomics variables and aid-growth relationship from regional and country-specific perspectives.

The statistical difficulties in estimating aid-growth coefficients are highly relevant and lead to different empirical results. Primarily, two statistical difficulties, namely, endogeneity in variables and inconsistency in estimators are announced. Boone (1994), Hadjmichael et al (1995) and Durbarry et al. (1998) addressed the existence of endogeneity in regressions by additionally introducing aid square as regressor and concluded that multilateral lending is positively related to growth, but with decreasing marginal returns to lending inflows. However, following the research of Boone and Hadjmichael, Burnside and Dollar (2000) rejected the endogeneity in variables by Durbin-Wu-Hansman statistics testing and also introduced an interaction term between aid and an index of economic policy. They note that under an index of 3 policies (budget surplus, inflation and openness), measured by the indicator variable

defined by Sachs and Warner (1995), aid plays a greater role on growth. In other words, fewer policy distortions facilitate aid effectiveness. Recently, Tseday Jemaneh Mekasha and Finn Tarp (2013) suggests a positive and statistically significant long-run effect of aid on income by employing the VAR model (Vector Autoregressive) to better address the inherent existence of endogeneity problems among variables.

The inconsistency problem in estimators are widely discussed as well.Recent research argued that estimators Burnside and Dollar used are inconsistent so that the test statistics are unreliable and improved the regression model by applying GMM (Generalized Method of Moments model) and instrument variables. Markus Brückner (2009) concluded the statistically significant positive effect on per capita GDP growth of aid recipient countries using rainfall as instrument variables to generate exogenous variation in per capita GDP of 47 LDC countries during the period 1960-2000 when the endogenous response of foreign aid is quantified.

Many empirical findings deal with the relationship between aid and key macroeconomics variables, especially in public and private investment and policy index. Easterly (1999) has identified positive and significant aid-investment link, thus concluding aid-growth link by employing financing gap model as called Harrod-Domar-Chenery Two Gap model which predicts a fixed linear and one-to-one relationship between growth and investment in the short run. Similarly, Obstfeld (1999) also has found positive relationship between aid and investment and consumption, thus promoting economic growth, provided that the economy is below the steady state. The focus on private investment is also interesting. Mahadvi (1990) has found a positive but insignificant relationship among private investment, private credit, and aid but was challenged by Snyder(1996) who pointed out a statistically significant negative association between aid and private investment. Hadjimichael et al.(1995) focused on Sub-Saharan African Countries and found that the relationship is positive for countries under structural adjustment and negative for countries with negative per-capita growth. Faini et al (1991) and Bird and Rowlands (2001) have

both pointed out an absent or even negative correlation between multilateral lending and private credit, which contradicts the expectations of international lending institutions to have a positive catalyst effect that can promote other capital flows, thereby contributing to economic growth. Contrarily, Evrensel (2004)) compares the cost of multilateral debt and private lending and argues that the effectiveness of aid is highly related to the difference of two costs. The aid is expected to be effective if the cost of multilateral debt is less than that of private lending, as private lending is more closely related to the reputation and credibility of the recipients in implementing policy reform.

Recently, the macroeconomics of aid continues to be a rich area for policy-relevant research. Tony Addison and Finn Tarp (2015) of UNU-WIDER, Helsinki, Finland in their recent paper "Aid Policy and the Macroeconomic Management of Aid" have pointed out the positive relationship between aid and economic growth and human capital as well by studying the supply-side of aid. However, the paper denies the determined role of aid on the economic growth or human capital development since the vulnerability of the development budgets resulted from the volatility of aid in less developed countries and suggests that effective reconfiguration, design and implementation of aid requires the deeper understanding of aid's impact on policy environment. However, Rajan and Subramanian (2008) argues that the aid-policy link is not robust, hence making the arguments that aid is insignificant, irrespective of economic policy.

Regional and country-specific aid-growth relationship is one of the heated empirical research as well. Geographic, demographic and policy quality are taken into account when empirical research conducted. Dalgaard et al (2004) has pointed out diminishing effectiveness of aid in the geographic tropics from the perspectives of climate variation. Mosley et al (1987) studies the aid-growth relationship through regions and states that there is a positive impact of aid on growth in Asian and Latin America, but a negative impact in Africa. Rajan and Subramanian(2005) pointed out a little robust

evidence of a positive (or negative) relationship between aid inflows into a country and its economic growth by using panel and cross sectional data. Evidence in the paper states that aid works better in better policy or geographical environments, or that certain forms of aid work better than others.In recent literature, Rachel M. Gisselquist (2015) of UNU-WIDER, Helsinki, Finland explored the impact of fragility of states in policy and legitimacy on aid effectiveness. He stated the importance of considering varieties of fragility and applying of best practices according to different features among states on the aid effectiveness.

Through literature review, majority of research are based on cross-country growth regression on the aid, taking into account macroeconomics variables and how the lending allocates to individual sectors within recipient countries. However, the sign of coefficients between aid and economic growth relationship can be varied among situations and further research is needed to confirm and improve.

2.2 Literature Findings on infrastructure-growth relationship

Well planned and well-implemented investments of developing countries are critical in all stages of development. This section discusses direct and indirect impact on the effects of infrastructure on productivity of inputs, statistical problems in finding the infrastructure-growth relationship and regional issues on this topic as well.

Through increase in public spending on infrastructure, economic activities can change both directly and indirectly. Infrastructure can be directly considered as additional input in the production process or indirectly improve total factor productivity by reducing transaction costs, ensuring an efficient use of traditional productive inputs.
Formal empirical literature and informal case studies on the infrastructure-growth relationship, however, never reach a unanimous result. Early empirical research, for example, Aschauer (1989) reported a positive relationship between infrastructure and economic growth by estimating very high elasticity of private output with respect to

public capital 0.35 to 0.45 which was confirmed in Munnell (1990), Otto and Voss (1994). Achauer (1989) pointed out that slower growth in public capital accumulation contributes to private sector productivity slowdown, thus leading to economic downturn in the 1970s and 1980s. A report from IMF in 2014 'Is it time for an infrastructure push? the macroeconomic effects of public investment' finds out positive relationship between public infrastructure investment and output in both short and long term, especially in economic slack periods. However, the constitute of public investment determines the degree of output increase via infrastructure development. The report finds out that an increase in public investment that is debt financed would have larger output effects than an increase that is budget neutral. Augustin Kwasi Fosu (2014) focused on the Sub-Saharan African and estimated a strong long-run relationship between public investment and growth by introducing various econometric techniques, such as System GMM estimation and endogenous growth model. The paper finds the growth maximizing public investment GDP share of about 10:2 percent and the complementary and crowding-out effects were detected strongly between public and private investments. In addition to research on the direct effects of infrastructure on productivity of inputs, some empirical literature has the attempt to figure out indirect effect and externalities. Pierre-Richard Agenor and Blanca Moreno-Dodson introduced indirect effects of health, education in endogenous growth model in Agenor and Moreno-Dodson (2006) and discussed the optimal allocation of public expenditures to find the infrastructure-growth relationship.

However, some empirical research tends to find smaller effects on infrastructure-growth relationship and criticizes early literature with its unsophisticated methodological approaches which ignore the non-stationary of aggregate output and infrastructure capital, potential simultaneity between infrastructure and income level and potential heterogeneity across countries (Calderon et al, 2011, Esfahani and Ramirez, 2004). To address the problem of non-stationary between two variables (infrastructure and aggregate output), panel time-series approach is widely used in the recent literature. César Calderón, Enrique Moral

Benito, Luis Servén (2012) estimates a long-run aggregate production function relating GDP to human capital, physical capital, and a synthetic measure of infrastructure comprising transport, power and telecommunications by using a panel time series and cross-country data set. The issue of potential simultaneity is also one of the most problematic one. Generally speaking, there are two solutions. The first solution is to use instrumental variable approach, ideally featuring outside instruments. For example, Calderón and Servén (2003, 2008) employ demographic variables as instruments -- alone or in combination with internal instruments -- in a generalized method of moments (GMM) panel framework. The second solution is the use of the use of stripped-down versions of Barro's (1990), an endogenous growth framework in which defines the welfare-maximizing level of productive expenditure that determines whether the positive shocks to infrastructure stocks will increase the output. For example, Canning and Pedroni (2004) added stochastic disturbances to Barro's structural equations and concluded that there is a growth maximizing level of infrastructure above which the diversion of resources from other productive uses outweighs the gain from having more infrastructure. Below this level, increases in infrastructure provision increase long run income. The third problem, namely, heterogeneity across countries is pervasive as well. Bogetic and Fedderke (2006) deals with the problem by employing a pooled mean-group approach that allows for unrestricted short-run heterogeneity in the impact of infrastructure and imposing long-run homogeneity of its effects across countries or industries.

Regional issues on infrastructure-growth relation are the another widely-discussed topic because aggregate economic growth on public infrastructure might veil the individual sector performance. Morrison and Shwartz (1996) employed the state-level data for US manufacturing sector and found out that infrastructure investment provides a significant return to firms and augments productivity growth. Conolly and Fox (2004) also suggests a positive and significant impact of public capital on private multifactor productivity for manufacturing and wholesale and retail by analyzing data throughout 11 sectors from year 1965-2001 in Australia. Stéphane Straub Charles

Vellutini Michael Warlters examined infrastructure and economic growth in East Asia in the World Bank Policy research paper (April, 2008) and concluded that the encouraging effects on economic growth decrease gradually. More recently, Roberts et.al.(2012) investigated the national and spatial impacts of the second largest transportation project in China---the National expressway Network (NEN) on the inequality reduction in real wage between urban and rural areas. The paper applies innovative five-stage methodology which assigns values to key model parameters through a mixture of calibration and estimation for parameter and structural new economic geography (NEG) --based evaluation model instead of conventional difference-in-difference approaches. The model results suggest Chinese real wages increase after NEN investment, especially in East of China but no significant effect on inequality reduction in real wage between rural and urban areas.

To conclude, research and studies on infrastructure-growth and aid-growth relationship are far from unanimous and findings vary due to the difference in methodological approaches, model selection and regional issues.

3. Thesis Background

3.1 Overview of Asian Infrastructure Bank

Asia is one of the most dynamic and fast-growing regions. In order to support and ensure fast growth and poverty reduction in Asia, the region requires overall national infrastructure investment needs estimated to be 8 trillion over the 2010-2020 period or $730 billion per year, in which 68% investment is for the new capacity and 32% is for maintaining and replacing existing infrastructure, according to Asian Development Bank (ADB). The top 10 Asian countries for Infrastructure Investment needs in 2010-2020 are shown in the table 3.1

Table 3.1 Total National Infrastructure Investment needs in Asia 2010-2020
(Top 10 countries, US $ dollars)

Countries	US dollars
PRC	4368
India	2172
Indonesia	450
Malaysia	188
Pakistan	179
Thailand	173
Bangladesh	145
Philippines	127
Vietnam	110
Kazakhstan	70

Sources: Infrastructure for Seamless Asia. ADB/ADBI (2009) and Stone (2008);The Global Competitiveness Report 2011‐2012, World Economic Forum

Asian Development Bank also estimated the four key infrastructure priority areas (see table 3.2)

Table 3.2 Key infrastructure priority areas
(US $ dollars)

Sectors	US (per year)	% total
Energy	374	51
Transport	225	31
Telecommunication	96	13
Water and Sanitation	35	5

Sources: Infrastructure for Seamless Asia. ADB/ADBI (2009) and Stone (2008); The Global Competitiveness Report 2011‐2012, World Economic Forum

However, the World Bank and ADB cannot close the infrastructure funding gap. The ADB, for example lends only 10 billion annually for infrastructure and the World Bank focuses more on gender equality and environmental protection. Under these circumstances, AIIB was established.

AIIB is a multilateral lending institution aiming at financing infrastructure development around Asia, including energy and power, transportation and telecommunications, rural infrastructure and agriculture development, water supply and sanitation, environmental protection, urban development and logistics, etc. and closing the infrastructure funding gap under the objective of lean (a small efficient management team and highly skilled staff), clean (an ethical organization with zero tolerance for corruption), green (an institution built on respect for the environment).

Proposed by China in 2013, AIIB launched at a ceremony in Beijing in 2014 and had 57 Prospective Founding Members, including almost all Asian countries, major countries outside Asia, such as Australia, Germany, UK, Switzerland, Sweden,

Denmark, Norway, Finland, Spain, Italy etc. by 15th, Apr, 2015. United States, Japan and Canada have no immediate intention to become prospective funding members and North Korea, Taiwan's applications were rejected.

3.2 Comparison of AIIB with other international lending organizations

The AIIB is the first Asian-based international bank to be independent from the Western-dominated Bretton Woods institutions, the International Monetary Fund (IMF) and the World Bank. Although AIIB has the same function with IMF, World Bank and ADB as a lending institution, it still differentiates itself in membership, shareholdings, financing, business and political goals etc.

3.2.1 AIIB and ADB

The Japan-led Asian Development Bank (ADB) is the institution that is most similar to the AIIB in name, geographic coverage and likely structure. However, AIIB still has its own features which serves as complements to ADB. AIIB and ADB have basic differences in headquarters, leading country, settlement currency, business focus (see table 3.3)

Table 3.3 Basic differences between ADB and AIIB

	ADB	**AIIB**
Headquarter	Manila	Beijing
Year	1966	2013
Leading country	Japan	China
Settle currency	US dollars	To be announced (US dollars, Chinese yuan or AIIB basket currency)
Business and funding focus	Sectors related to reduce poverty and development, such as infrastructure, health and education etc	Infrastructure especially

Source: Author's conclusion

Also, AIIB distinguishes with ADB in membership and shareholdings. The comparison in the membership and shareholdings are shown in the table 3.4.

Table 3.4 Comparison of AIIB and ADB in membership and shareholdings

	ADB	**AIIB**
Members in Asia	67 ADB members with 19non-regional members	57 prospective funding members with 20 non-regional members
Board of Directors	7 of 10 positions reserved for regional members	9 of 12 positions reserved for regional members
Shareholdings	Non-regional members account for over 30% of shareholdings 12.84% shareholdings for Japan	75-25 split between Asian and non-Asian Members About 27% shareholdings for China
Member of Pacific Island states	13 island states in 48 regional members	None of island states in regional members

Source: Author's Conclusion

Obviously from the tables above, although AIIB welcomes more non-regional members, it provides a more secure benefit for Asian Members by the mechanism of 75-25 split shareholdings than ADB does. In addition, AIIB gives China a big role while gives Japan a smaller role compared with that of China.

Finally, AIIB and ADB have distinctions in financing and capital structure (see table 3.5). Although the scale of AIIB is smaller than that of ADB in the initial capital, if successful in building reserves from retained earnings and other sources, it could eventually reach a similar loan-paid-up capital ratio as ADB (12.7). However, AIIB funding members have more pressure than ADB funding members in paid-up Capital.

Table 3.5 Comparison of ADB with AIIB in Financing and Capital structure
(US $ billion dollars)

	ADB	AIIB
Initial capital	100	50
Paid-up capital	5.9	10
Loan Portfolio	7.5	Estimated 127
Loan-capital ratio	12.7	Estimated 12,7

Source: Various Press releases and annual reports (assessed on 30 March 2015 at the MDB website)

In spite of differences between two international funding institutions, Asia needs two banks to support growing demand for infrastructure funding and AIIB will not compete ADB but complement AIIB, said by Chinese Authorities.

3.2.2 World Bank, IMF and AIIB

World Bank and AIIB are both international lending institutions and share many similarities in spite of different business focuses, goals, management structure, shareholdings etc. The past experience of World Bank could be a good lesson for AIIB on its future development. However, IMF, is not a lending institution but a credit union and has focused on unresolved financial problems, such as unpredictable variation of currency exchanges. IMF oversees its members' monetary and exchange rate policies and guards code of conduct.

To understand deeply the differences between World Bank, IMF and AIIB, we need to know well major concerns of China and other Asian emerging countries when engaging the business and voting in IMF and World Bank. The first concern is that the

unfair voting share in two institutions for Asian emerging countries. China and other Asian emerging countries have argued a long time for their unfair voting share in IMF and World Bank. In the case of IMF, China, Russia, India have far less voting shares than they deserve according to the GDP sizes and the same situation happens in the case of World Bank. For instance, the Executive Board of IMF gives France, with a $3 trillion GDP, far more votes than China with a 2014 GDP of more than three times as large at $10 trillion, or gives Belgium (1.86%) with a $500 billion GDP a larger voting share than Brazil (1.72%) with a GDP more than four times as large at $2.2 trillion.

The second concern is the low efficiency of project preparation and risk aversion of borrowing in the World Bank. The Ernesto Zedillo[1]'s report in October 2009 is quite critical of the current World Bank arrangement of a resident board that approves all loans. He argued that he World Bank is criticized by its inefficiency and bureaucracy due to its unreasonable board and management structure, namely, resident board and extra layer and implementation of environmental and social safeguards, which move developing countries away from existing multilateral development bank to finance infrastructure projects. In contrast, AIIB is expected to improve its board and management structure to make business process more efficient and smoother by introducing non-resident board.

Finally, the World Bank exists to encourage poor countries to develop by providing them with technical assistance and funding for projects and policies that will realize the countries' economic potential. AIIB focuses on middle-income countries and regions in Asia and primarily on economics rather than politics. The following figure briefly discusses the major differences between AIIB and World Bank. (see Table3.6)

In spite of existing differences between AIIB,IMF and World Bank, the World Bank

[1] Former president of Mexico, chaired the High-Level Commission on Modernization of World Bank Group Governance

highlighted the importance of undertaking "comprehensive structural reform programs" in developing countries to promote growth, in line with the IMF World Economic Outlook April 2015, released on Tuesday and both welcomed AIIB, hoping to work hand-in-hand to prosper the LDCs.

Table 3.6 Comparison between World Bank and AIIB

	World Bank	AIIB
Voting Rights	Voting power dominated by Europeans and the Americans	Voting power dominated by Asian Emerging countries, especially China
Goals	Focused on both economics and politics	Focused on economics and less politics
Beneficiaries	Developing countries	Developing countries, especially
Board and Management	Resident Board with financial cost $ 70 million per year. Extra layer of management	Non-resident board that meets periodically in Beijing or through video conference. Delegate more decision making to management
Efficiency	Slow and Bureaucratic	Expected to be quicker and more efficient
Shareholdings	Governments of its 180 member nations with equity shares	75-25 split between Asian and non-Asian Members About 27% shareholdings for China

Source: Author’s conclusion

4. Research Methodology

4.1Theoretical Framework

In order to specify the theoretical framework, the research on the channels that infrastructure impacts on the economic growth is required. In the book "Public Capital, Growth and Welfare" by Pierre-Richard Agenor, he points out the potential channels through which public capital may contribute to the long run GDP growth or income per capita, including the productivity-channel, complementarity between public infrastructure services and private inputs, education and health, the level of country's innovation capacity, efficiency of women's time allocation, diffusion of existing technology.

In the first Chapter of Agenor's book, he employed two-period overlapping growth (OLG) model to specify the channels through which public capital affects long-run economic growth. Agenor finds out that the production inputs are complement, implying that the increase of one input will also raise productivity of the other inputs, thus reducing the cost of production unit. Therefore, the increase of public capital on infrastructure will raise the productivity of private capital. For instance, the return rate of building a factory in manufacture sector using private capital are likely to be higher if the infrastructure such as transportation, electricity and water station is already constructed. In addition, Agenor also points out the crowding-out effects, meaning that production of new public capital depends not only the investment inflow but also the existing public capital stock and the rises in public sector spending also drive down or even eliminate private sector spending.

In the following chapter, the other important channels are discussed, among which human capital is taken into account most commonly in empirical work. The public investment on social infrastructure will benefit health and education of labor force, thus inducing more literacy, better health condition and manpower skill which are

important factors for higher productivity and growth.

In the basic framework, Agenor considered an economy populated by an infinitely lived representative household, which produces and consumes a single traded good. The government invests in infrastructure, spends on maintenance and meets its budget by a flat tax rate on output. The production structure of the framework is relevant to the thesis empirical work and is specified by Agenor as follows:

$$Y = (eK_G)^{\alpha} K_p^{1-\alpha} \tag{1}$$

$$e = (M / K_G)^{\chi} \qquad \chi \in (0,1) \tag{2}$$

$$K_p = I_p - \delta_p K_p \qquad \delta_P \in (0,1) \tag{3}$$

Output Y is produced by private capital K_p and the effective stock of public infrastructure capital eK_G where $e \succ 0$ is the efficiency and is a concave function of the ratio of public spending on maintenance, M, to the stock of public capital. I_p denotes gross private investment and δ_p is the depreciation rate of private investment. Also the production function is assumed to constant return to scale Cobb-Douglas.

Under the background of the thesis, the neoclassical growth model should be adjusted and is expected to include public capital, private capital, infrastructure stock (I_t), official development aid (ODA) [2]and ease of doing business index ($EODB_t$) which will be discussed in the following section. Cobb-Douglas production function is assumed to be constant return to scale. Also, in the model, the human capital is not considered because AIIB primarily focuses on the infrastructure projects such as energy and power, transportation and telecommunications, rural infrastructure and

[2] Since part of ODA has been used for public investment, the double counting problem arises. The details and the methodologies to exclude the problems are discussed in the Appendix 2.

agriculture development etc. and little on social infrastructure such as school and hospital that have a large impact on human capital accumulation. Therefore, the human capital factor is negligible in AIIB case. The neoclassical growth model can be adjusted as follows

$$Y_t = f(Kpub, LF, Kpvt, EODB_t, I_t, ODA) \quad (4)$$

Where Y_t is GDP per capita in an economy using inputs such as private (K_{pvt}) capital, public capital (K_{pub}) , labor force (L), infrastructure stock (I_t) , Official Development Aid (ODA). $EODB_t$ refers to the ease of doing business index available at World Bank

After reviewing the theoretical framework of the growth model, the following sections will deal with the measurement of the production inputs and set up the econometric model for analysis.

4.1.1 Infrastructure Index

The existing empirical literature and working paper have developed some indicators of physical infrastructure development to examine the relationship between infrastructure development and economic growth, among which FTSE Global Infrastructure Index Series, S&P Global Infrastructure Index and Global Infrastructure Investment Index are commonly used and discussed. FTSE infrastructure index is comprised of 6 broad industry sectors----3 core infrastructure sectors, namely, transportation, telecommunication, energy and 3 infrastructure-related sectors, namely, related Materials & Engineering, related Conveyance Services, related Communications Services. FTSE global infrastructure index includes the companies in the core sectors which generate 65% of revenue from infrastructure and employs

capping methodology[3]to avoid overweight in any particular sectors.

S&P global infrastructure index has the same focus with FTSE global infrastructure index on the 75 liquid and representative infrastructure companies worldwide but takes three distinct infrastructure clusters: energy, transportation, and utilities. Also, the infrastructure index serves as the investment benchmark. Investors and asset owners need to be wary of the differing risks and potential opportunities each market presents them with.

Global Infrastructure Investment Index is a dominant index for investors to well adopt their investment strategy in economic infrastructure which takes into account 24 individual criteria including mainly 5 aspects, such as country risk, quality of existing infrastructure, ease of doing business, political and social environment and financial conditions etc.

For the AIIB case discussed in the thesis, we use the infrastructure indicators presented by the World Bank of related Asian developing countries which correspond to 6 infrastructure projects AIIB focuses [4] and develop the composite index of these major infrastructure indicators. The infrastructure indicators are (1) Electricity Power Consumption (KWh per capita) (2) Improved water source, rural (% of rural population with access) (3) Rail Line (Total route-km) (4) Fixed (wired) broadband subscriptions (per 100 people) (5) Air transport registered carrier departures, world (6) Mobile Celluar Subscription (per 100 people). The six indicators can be used to well represent the infrastructure development goal of AIIB.

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3 Capping Method: an index construction method employs market capitalization weighting where each constituent in the weighting is weighted by its float-adjusted market capitalization.

4 The AIIB infrastructure projects are (1) energy and power, (2) transportation and telecommunications, (3) rural infrastructure and agriculture development, (4) water supply and sanitation, (5) environmental protection, (6) urban development and logistics, etc

In order to provide composite index[5] of major infrastructure indicators, the infrastructure index is derived from the principal component analysis, a commonly used multivariate statistical technique and one of the most important results from applied linear algebra. Principal Component Analysis, or simply PCA, is a statistical procedure concerned with elucidating the covariance structure of a set of variables and interprets the original data set into a few variables usually called as principal components. The core part of PCA is the application of eigenvalues and in computational terms, the principal components are found by calculating the eigenvectors and eigenvalues of the data covariance matrix[6]. The table 4.1 shows the Eigen values and variance. The final infrastructure index for China and the calculation results for other 4 countries are presented in Appendix1. The table 4.2 presents factor loading of original values according to eigenvalues and the factor loading of original values of other 4 countries are also shown in Appendix 1.

Table 4.1 Eigenvalues and Variance explained by principal components (China)

Infrastructure Index for China			
Principal components	Values	% of Variance	Cumulative values
1	5.733388	0.9556	0.9556
2	0.226142	0.0377	0.9933
3	0.029854	0.005	0.9982
4	0.005789	0.001	0.9992
5	0.00306	0.0005	0.9997
6	0.00176	0.0003	1

Source: Author's Calculation

5 The thesis focuses on the impact of whole infrastructure stock on the economic growth, therefore, the composite index is used instead of individual indices.

6 This process is equivalent to finding the axis system in which the co-variance matrix is diagonal. The eigenvector with the largest eigenvalue is the direction of greatest variation, the one with the second largest eigenvalue is the (orthogonal) direction with the next highest variation and so on.

Table 4.2 Factors loading of original values (China)

China	
Infrastructure Variables	Loadings
Air transport registered carrier departures, world	0.416835
Electricity Power consumption(KWh per capita)	0.415675
Fixed(wired)broadband subscriptions (per100 people)	0.39866
Improved water source, urban(%urban population with access)	0.403092
Mobile phone subscription (per 100 people)	0.414716
Rail Line (Total route-km)	0.400075

Source: Author's calculation

After calculating the eigenvalues and corresponding factor loading, we can derive the final infrastructure index for the specific time period t and the formula is specified as follows

$$INDEX_t = 0.415835 * ATR_t + 0.415675 * EPC_t + 0.39866 * FBS_t + 0.403092 * IWS_t + 0.414716 * MPS_t + 0.400075 * RL_t \quad (5)$$

Where $INDEX_t$ is final infrastructure index, ATR_t represents air transport registered carrier departures, world, EPC_t represents electricity power consumption (KWh per capita), FBS_t represents fixed (wired) broadband subscriptions (per100 people), IWS_t represents improved water source, urban (% urban population with access), MPS_t represents mobile phone subscription (per 100 people) and RL_t represents rail line (Total route-km). For simplicity, a simple average of the

loading values, that is approximate 0.4 can replace the actual loading values and will not affect the final regression results.

4.1.2 Ease of doing Business Index

After defining the infrastructure index, it's also important to consider ease of doing business index in the empirical model. The ease of doing business index from gives the equal weight to 10 indicators which assess the environment for investment, The 10 indicators are starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency.

Assessing the ease of doing business is relevant especially when doing infrastructure projects since in developing countries, more progress is made to strengthen the collaboration of private capital and public capital, such as the advocating PPP (Public-private partnership) mode by Chinese government in 2014. A higher ease of doing business index implies a more conducive environment for investment, therefore providing a more favorable force for GDP growth and is expected to be positive in coefficient.

4.1.3 Data Sources

World Development indicators—World Bank: Investment is defined as gross fixed capital formation (% of GDP) and private capital (investment) is represented as Gross fixed capital formation, private sector (% of GDP). Public capital (investment) is obtained from the difference between the gross fixed capital formation and gross fixed capital formation, private sector[7], Labor force is taken from World development indicator, total labor force and official development aid is represented by Net official

[7] The data of gross fixed capital formation, private sector (% GDP) is unavailable for China and Indonesia in the World Bank database. Under this situation, we only consider public investment in the two countries

development assistance and official aid received (ODA) (current US dollars). The data of domestic credit is extracted from World Bank indicator, domestic credit (% of GDP). Annual data of GDP per capita (current US dollars) is used

World Bank Indices: Ease of doing business index is extracted from World Bank doing business data.

The time period for research is 1992 to 2011

4.2 Econometric Model

Assuming a generalized Cobb-Douglas production function and extending the neoclassical growth model to include infrastructure stock and official development aid and separate capital into public and private, the neoclassical growth model introduces more inputs and can be expressed in the natural logarithm in the following equations to empirically examine the impact of infrastructure stock and ODA on the GDP for a specific Asian country.

$$LnGDP_t = \alpha + \beta t + LnKpub_t + LnKpvt_t + LnLF_t + LnIndex_t + LnEODB_t + LnODA + \mu_t \quad (6)$$

Where GDP_t is real gross domestic product per capita, $Kpvt_t$ is domestic private investment (private capital), $Kpub_t$ is public investment (public capital), LF is total labor force, Index is infrastructure index which is discussed in the previous context, ODA_t is official development aid. $LnEODB_t$ is the ease of doing business index. βt is the trend term.

The empirical model studied has three problems needed to be avoided through

suitable econometric methodology and refined data measurement. First, the reverse causality problem in the empirical model is severe. Infrastructure development might increase the productivity and efficiency in both public and private sectors, leading to the output growth and economic development. However, it's also possible and understandable that the economic growth facilitate the demand for the infrastructure development, for instance, the economic growth stimulates the social demand for imported goods, which might generates the infrastructure construction of logistics system. Therefore, whether infrastructure development leads to output growth or the reversal of the relationship should be justified in the model. In order to ascertain the direction of causality between infrastructure and GDP growth, Granger Causality (see Engle and Granger, 1987) is applied. Engle points out that a variable X Granger-causes Y if Y can be better predicted using the histories of both X and Y than it can using the history of Y alone. However, Granger causality is not necessarily the true causality since it may produce misleading results when the true relationship involves three or more variables.

Second, the double counting problem also exists in the model. The official development aid can be included in the public investment but it still appears as an explanatory variable in the model. Aid is intended to affect growth via its effect on investment. However, not all aid is intended for investment and not all investment is financed by aid. If one adopts the approach of omitting investment, the regression is misspecified and the estimated coefficient on aid is biased. Thus, it is clear that only the coefficient on the aid variable is altered. Discussions about the problem can be found in the existing empirical paper, such as Feeny,2005 which points out the coefficient bias on the aid variable if either taking both as explanatory variables or omitting one of them. In present papers, this problem is addressed by employing transmission mechanism of investment. In cases where the 'transmission' variable (X) has a positive effect on growth, and aid has a positive effect on the variable, this method will provide for a larger coefficient on aid. If the variable has a negative effect on growth, and aid is a positive determinant of the variable, the coefficient on aid is

reduced. If it transpires that aid is not a determinant of the variable, there is no effect and the method is not use. The details of transmission mechanism of investment and regression results are discussed in the Appendix 1

The final problem is the endogeneity and the availability of long-run relationship estimation. The possibility of more than one endogenous variables can lead to biased estimates in the regression model if suitable methodologies are not adopted such as instrument variables. The endeogeneity mainly arises due to the correlation between ODA and income level (Boone 1994, Hadjmichael et al, 1995) and the correlation between government expenditure on social infrastructure and income level as well. Also, the thesis is interested in the long-run coefficient or relationship between key variables. To address the problem, ARDL approach to cointegration might be the good candidate for the following reasons. First, ARDL model better describes both the short-run and long-run relationship between dependent and explanatory variables which are both important to the research results. Second, ARDL Model has a wider scope. Traditional method to deal with co-integration such as Johansen-Juselius (J-J) is not effective if the variables don't share the same order of integration, in the most cases, I(1). However, ARDL Model can still be applied if the variables simultaneously have I (1) and I(0). Finally, he ARDL approach to cointegration employed gives consistent estimates in the presence of regressor endogeneity. Therefore, the combination use of ARDL Model, along with Granger causality analysis might be the optimal solution of the limitations in the empirical model the thesis studies.

To conduct the econometric analysis of the relationship between ODA, infrastructure stock and economic growth, there are several major steps required to be followed. The first step is to test for the existence of unit roots and determine the order of integration of the variables before using ARDL Model due to the limitation of order of integration using Augmented Dickey-Fuller test (ADF test). For security,

Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test[8] is also applied to confirm the non-existence of I(2) variables because KPSS test is preferred in smaller sample, pointed out by some econometric literature.

The second step is to establish the error correction version of the ARDL model. The optimal lag selection of error correction is based on Akaike Information Criteria (AIC) and the minimum value of AIC is the most preferable model. The general error correction version of the ARDL model is shown as follows

$$\Delta LnGDP_t = \alpha_0 + \delta_{1i}\sum_{i=1}^{p}\Delta LnGDP_{t-i} + \delta_{2i}\sum_{i=1}^{p}\Delta LnLF_{t-i} + \delta_{3i}\sum_{i=1}^{p}\Delta LnKpvt_{t-i} + \delta_{4i}\sum_{i=1}^{p}\Delta LnKpub_{t-i} + \delta_{5i}$$
$$\sum_{i=1}^{p}\Delta LnIndex + \delta_{6i}\sum_{i=1}^{p}\Delta LnODA_{t-i} + \delta_{7i}\sum_{i=1}^{p}\Delta LnEODB_{t-i} + \beta_1 LnGDP_{t-1} + \beta_2 LnLF_{t-1} + \beta_3 LnKpvt_{t-1}$$
$$+ \beta_4 LnKpub_{t-1} + \beta_5 LnIndex_{t-1} + \beta_6 LnODA_{t-1} + \beta_7 LnEODB_{t-1} + \mu_t \qquad (7)$$

Next, the diagnostic test should be employed to test the stability and accuracy of the error correction version of ARDL model. Five tests which are used commonly in econometrics research, namely, CUSUM test, Heteroskedasticity Test with ARCH method, Serial correlation LM test, Ramsey RESET Test and Normality Test are applied.

The fourth step is to test the existence of long-run relationship between variables and estimate the long-run coefficients if existing. The error correction version of ARDL Model has the null hypothesis (H_0) stating that $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$ to confirm non-existence of long run relationship between variables. The bounds testing is employed to check this long-run relation. To be specific, H_0 (null hypothesis) is rejected if the computed F-statistics exceeds the upper critical bounds value and cannot be rejected if the computed F-statistics falls below the lower bound

[8] KPSS test gives the double confirmation about the ADF test because some research literature has pointed out more accuracy of KPSS test in small sample size (Yin Pui Mun and Lau Sim Yee,2013)

value. However, the test becomes inconclusive if F statistic falls into the bounds. The upper and lower bound values are extracted from Narayan (2004, p.1988) and Pesaran et al. (2001, p. 300)

The fifth step is to check the direction of causality between infrastructure development and output growth. Before determining the appropriate approach of granger causality test, we need first take Johansen cointegration test[9] to find if there are cointegrating vectors among variables, infrastructure index and GDP. Although most literature presents the similar results between these two methodologies, Mahdi Mostafavi (2011) states in his paper when he tests for the long-run relationship between GDP and inflation that Johansen method for testing cointegration is more real and closer to theory in coefficient explanation compared with ARDL model to cointegration when two variables are analyzed due to the different techniques in estimation behind these two mentioned, i.e. Johansen method employs the Maximum Likelihood Estimation while the ARDL employs Ordinary Least Square. If there is no cointegrating vector, Cranger Causality VAR procedure is the candidate. We can test for the absence of Granger causality by estimating the following VAR model

$$\begin{aligned} Y_t &= \alpha_0 + \alpha_1 Y_{t-1} + \ldots\ldots\ldots + \alpha_p Y_{t-p} + b_1 X_{t-1} + \ldots\ldots\ldots b_p X_{t-p} + \mu_t \\ X_t &= c_0 + c_1 X_{t-1} + \ldots\ldots\ldots + c_p X_{t-p} + d_1 X_{t-1} + \ldots\ldots\ldots d_p X_{t-p} + v_t \end{aligned} \qquad (8)$$

Then we can use F-test to check the short-run Granger Causality with the null hypothesis..

H_0: $b_1 = b_2 = \ldots\ldots\ldots b_p = 0$ or X does not granger cause Y

$d_1 = d_2 = \ldots\ldots d_p = 0$ or Y does not granger cause X

In each case, a rejection of the null implies there is Granger causality.

[9] This test permits more than one cointegrating relationship so is more generally applicable than the Engle–Granger test which is based on the Dickey–Fuller (or the augmented) test for unit roots in the residuals from a single (estimated) cointegrating relationship

Primarily, we can derive two general models for Granger causality (see Engle and Granger, 1987) depending on the order of integration of variables. If all the variables are I (1) and cointegrated, the Granger Causality two-step VECM is basically given as

$$\begin{aligned}\Delta Y_t &= \alpha + \pi_y ECT_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta Y_{t-i} + \sum_{j=1}^{p-1} \gamma_j \Delta X_{t-j} + \mu_{yt} \\ \Delta X_t &= \lambda + \pi_x ECT_{t-1} + \sum_{i=1}^{p-1} \theta_i \Delta X_{t-i} + \sum_{j=1}^{p-1} \delta_j \Delta Y_{t-j} + \mu_{xt}\end{aligned} \tag{9}$$

Where lagged ECT is the lagged residuals from the cointegrating relation between Y and X can be expressed as

$$\begin{aligned}ECT_{yt-1} &= \overline{\mu}_{yt-1} = Y_{t-1} - \overline{B}_1 - \overline{B}_2 X_{t-1} \\ ECT_{xt-1} &= \overline{\mu}_{xt-1} = X_{t-1} - \overline{B}_1 - B_2 Y_{t-1}\end{aligned} \tag{8}$$

After establishing the Vector Error Correction function(VECM), we can use F-test to check the short-run Granger Causality with the null hypothesis

H_0: $\sum_{j=1}^{p-1} \gamma_j = 0$ or X does not cause Y

$\sum_{j-1}^{p-1} \delta_j = 0$ or Y does not cause X

Or the long-run Granger Causality using t-test with the null hypothesis

H_0: $\pi_y = 0$ or Granger non-causality in the long run

$\pi_x = 0$ or Granger non-causality in the long run

In each case, a rejection of the null implies there is Granger causality.

5. Empirical Results and Discussions

This chapter presents the empirical results of long-run relationship in infrastructure-growth and aid-growth in five Asian developing countries, namely, China, India, Indonesia, Malaysia and Pakistan. The five recipient countries of AIIB demand the top in infrastructure aid and account for nearly 90% of the whole infrastructure investment needs in Asia, estimated by ADB. This chapter only discusses the case of China and Pakistan which rank the first and last in demand among these five countries in detail and lists the empirical results of the other three countries.

5.1 The Case of Pakistan

According to the steps discussed in chapter 4, ADF test and KPSS test are first conducted. In order to employ ARDL, it's necessary to ensure that the model variables are not I(2), that is, the model variables should contain mixed order of integration one and zero. The table 5.1 presents the results of ADF test to offer initial conclusion of order of integration in variables.

Table 5.1 ADF test for unit root (Pakistan)

Variables	ADF Test		Conclusion
	Level	1ST difference	
GDP per capita	-1.20	-3.57 *	I(1)
KPUBT	-1.46	-4.76	I (1)
KPVT	-1.88	-7.81	I(1)
LF	-3.32	-4.17	I(1)
ODA	-3.26	-5.43	I(1)
INDEX	-0.28	-5.70	I(1)
EODB	1.80	-6.92	I(1)

Source: Author's Calculation

Note: * indicates significance at 10% level

Also, KPSS test is applied to confirm the non-existence of I(2) variables.Since the KPSS test has the different null hypothesis that an observable time series is stationary, for simplicity, all the explanatory variables in the table 5.2 are differenced and the rejection of the differenced time series variables indicate the acceptance of I(0) variables. The test results are listed in the following table 5.2 [10]

Table 5.2 KPSS Test for unit roots (Pakistan)

Variables	KPSS Test	Conclusion
GDP per capita	0.16**	I(0)
KPUBT	0.12 *	I(0)
KPVT	0.12 *	I(0)
LF	0.16 **	I(0)
ODA	0.13 *	I(0)
INDEX	0.18**	I(0)
EODB	0.16**	I(0)

Source: Author's Calculation

Note: ∗ and ∗∗ indicate significance at 10% and 5%, respectively

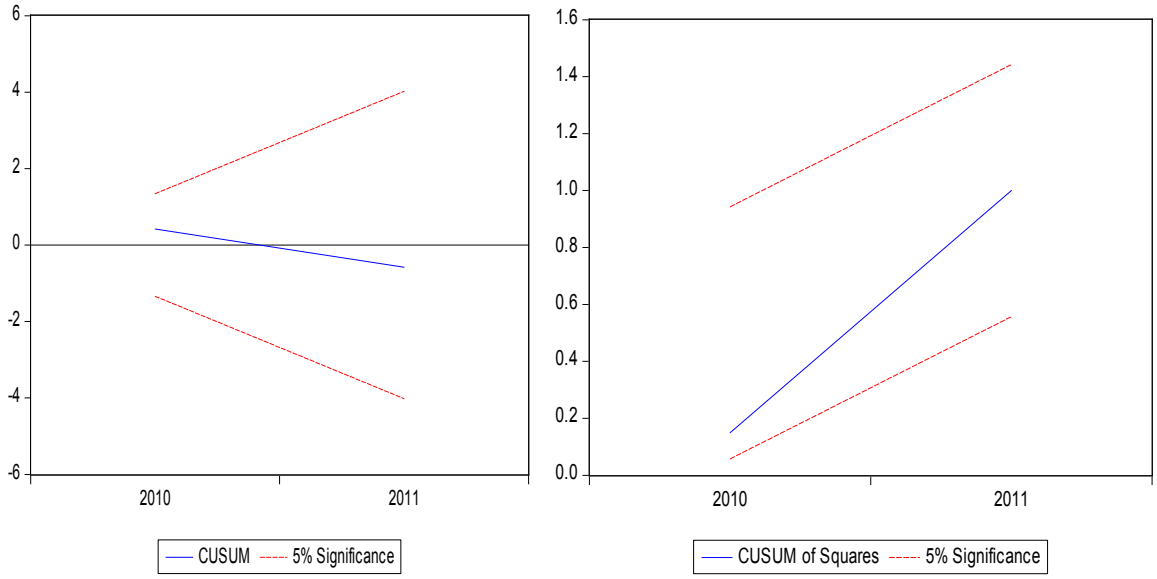
From the table above, we can safely conclude that the model variables don't contain order of integration two in spite of the different results calculated by two tests. After optimal lag selection, the error correction version can be specified as follows

$$\Delta LnGDP_t = \alpha_0 + \delta_{11}\Delta LnGDP_{t-1} + \delta_{21}\Delta LnLF_{t-1} + \delta_{31}\Delta LnKpvt_{t-1} + \delta_{41}\Delta LnKpubt_{t-1} + \delta_{52}\Delta LnIndex_{t-2} + \delta_{60}\Delta LnODA_t + \delta_{61}\Delta LnODA_{t-1} + \delta_{70}\Delta LnEODB_t + \beta_1 LnGDP_{t-1} + \beta_2 LnLF_{t-1} + \beta_3 LnKpvt_{t-1} + \beta_4 LnKpubt_{t-1} + \beta_5 LnIndex_{t-1} + \beta_6 LnODA_{t-1} + \beta_7 LnEODB_{t-1} + \mu_t \quad (9)$$

[10] The variables analyzed in KPSS test in the following context are all differenced.

In order to check the model stability and correctness, we set up five tests which are used commonly in econometrics, namely, CUSUM test, Heteroskedasticity Test with ARCH method, Serial correlation LM test, Ramsey RESET Test and Normality Test. The model can be valid if it passes all the tests mentioned. The figure 5.1 presents the CUSUM test results to make sure the stability of the model.

Figure 5.1 Plot of CUSUM and CUSUM of square of the ARDL model



Source: Author's Calculation

The test results for serial correlation, heteroskedasticity, normality and omitted variables are stated as following table 5.3.

Table 5.3 Diagnostic test results for ARDL Model (Pakistan)

Test	Test statistics	Probability Value	Conclusion
Serial correlation LM test	68.71	0.08	Cannot reject null hypothesis : No serial correlation
Ramsey RESET Test	0.79	0.57	Cannot reject null hypothesis: Homoskedasticity
Heteroskedasticity Test ARCH method	0.98	0.34	Cannot reject null hypothesis: no heteroskedasticity
Normality Test	1.05	0.59	Cannot reject null hypothesis: Normally distributed

Source: Author's Calculation

After testing the validity of the model, the regression can be made to estimate long-run relationship between variables. To test the significance of long-run relationship, we need to take Wald test (bound testing for ARDL model) and compare F test statistics with critical values extracted from Narayan (2004, p. 1988) and Pesaran et al. (2001,p. 300) for the corresponding order of integration. The following table shows the ARDL bound testing results and estimates the coefficients between explanatory variables and dependent variables GDP

Table 5.4 Bound test results for Cointegration (Pakistan)

Test statistics	Value	df	P Value
F statistic	73751.36	(7,1)	0.0167
Chi-Square	516259	7	0.0000
Critical values extracted from Narayan (2004, p. 1988) Upper Bound Value in the case of intercept and no trend			
	I(0)	I(1)	
1% 5% 10%	4.768 3.353 2.752	6.670 4.774 3.994	
critical values extracted from Pesaran et al. (2001,p. 300) Upper Bound Value in the case of intercept and no trend			
	I(0)	I(1)	
1% 5% 10%	3.74 2.86 2.45	5.06 4.01 3.52	

Source: Author's Calculation

Note: The critical values of the lower bound and upper bound are obtained from Narayan (2004, p.1988) and Pesaran et al. (2001, p. 300) for the case of unrestricted intercept and no trend.

From the table 5.4, we can find that F statistic value exceeds the upper bound value of 1% significance level for I(0) and I(1) in both Narayan (2004, p. 1988) and Pesaran et al. (2001,p. 300). Therefore, we can undoubtedly reject the null hypothesis that the long-run coefficients are jointly insignificant. In order words, there exists a long run relationship and the bound testing result provides the theoretical basis for estimation for long run coefficients of variables from ARDL model. The estimated long-run relationship coefficients are listed in the following table.

Table 5.5 Estimated Long run coefficients of variables (Pakistan)

Dependent Variables: (LNGDP)				
Variable	Coefficient	Std Error	t statistics	P Value
C	-24.90137	5.5079	-4.521028	0.0007
LNKPUBT	0.745033	0.002705	275.386	0.0023
LNKPVT	0.413513	0.133628	3.094509	0.0093
LNLF	0.3416	0.385207	0.886958	0.3925
LNODA	0.549011	0.002124	258.4504	0.0025
LNINDEX	0.4598	0.4704	0.977568	0.3476
LNEODB	3.3473	2.50915	1.334038	0.2070

Source: Author's Calculation

As indicated from the table5.5, we can clearly find out the positive relationship between GDP per capita and explanatory variables in the long run in the case of Pakistan. The variables, private investment, public investment, ODA. have significantly positive impact on the economic growth for the case of Pakistan in the long run. The estimated coefficient suggests that infrastructure stock, labor force, and ease of doing business index, though might benefit the economic growth in Pakistan in the short-run have no significant effect on the economic growth in the long run.

Since the problem of reverse causality is discussed in the previous context and other econometric literature regarding the infrastructure-growth relationship, the methodology of Granger causality test is employed to test the direction of feedback between infrastructure and economic growth in selected countries. First, it's necessary and important to test for existence of cointegrating vectors using Johansen approach because whether the use of Granger causality VECM method or Unrestricted VAR method is determined by the test result. The table 5.6 presents the results of Johansen approach to test for existence of conintegrating vectors between infrastructure and

GDP.

Table 5.6 Results of Johansen test for cointegrating vectors (Pakistan)

Test type	Trace/Max Eigenvalue	Trace/ Max-Eigen statistic	0.05 Critical Value	P value
Trace				
None	0.304942	6.733852	15.49471	0.6088
At most 1	0.031832	0.549938	3.841466	0.4583
Max Eigenvalue				
None	0.304942	6.183915	14.26460	0.5897
At most 1	0.031832	0.549938	3.841466	0.4583

Source: Author's calculation
Note:
The test assumes a linear deterministic trend in the data.
The lag length selected by Schwarz-Bayesian Information Criterion (SBIC) for the VAR analysis is two for model

The test result indicates no cointegrating vectors between two variables, infrastructure index and GDP per capita. Therefore, Granger Causality test using unrestricted VAR method should be applied in this case. The following two tables 5.7 and 5.8 represent the regression results of unrestricted VAR model.

Table 5.7 Regression results for VAR Model with dependent variable GDP (Pakistan)

Dependent Variable: LNGDP				
	Coefficient	Std.Error	t Statistic	P value
LNGDP(-1)	0.75906	0.255014	2.960254	0.0111
LNGDP(-2)	0.154411	0.247267	0.624470	0.5431
LNINDEX(-1)	0.260938	0.204622	1.275222	0.2245
LNINDEX(-2)	-0.666992	0.249259	-2.675894	0.0190
Constant	4.612963	1.791792	2.574497	0.0231

Source: Author's calculation

Table 5.8 Regression results for VAR Model with dependent variable infrastructure index (Pakistan)

Dependent Variable: LNINDEX				
	Coefficient	Std.Error	t Statistic	P value
LNGDP(-1)	-0.378000	0.317631	-1.190059	0.2553
LNGDP(-2)	0.435997	0.307983	1.415654	0.1804
LNINDEX(-1)	1.179086	0.254866	4.626298	0.0005
LNINDEX(-2)	-0.424260	0.310464	-1.366534	0.1949
Constant	2.047714	2.231759	0.917533	0.3756

Source: Author's calculation

After estimating the coefficients of unrestricted VAR model, Granger Causality Wald test should be taken to check the direction of causality between infrastructure stock and economic growth. In the table 5.9, the coefficients of LNINDEX(-1) and LNINDEX(-2) should be checked with the null hypothesis that both of them are 0, which indicates non-existence granger causality from infrastructure stock to economic

growth. Similarly, the coefficients of LNGDP(-1) and LNGDP(-2) should be tested whether they are jointly significant, implying that economic growth granger causes infrastructure stock. The result of Granger causality test using F statistics is listed in the following table.

Table 5.9 Results of Granger causality test between infrastructure and GDP

Causality between Infrastructure and GDP		
Dependent Variable	$\sum_{i=1}^{p} LNINDEX_{t-i}$	$\sum_{i=1}^{p} LNGDP_{t-i}$
	$\sum_{i=1}^{p} \beta_i = 0$: F-Statistics (P value)	$\sum_{i=1}^{p} \beta_i = 0$: F-Statistics (P value)
LNGDP	4.571755** (0.0314)	
LNINDEX		1.177299 (0.3389)

Source: Author's Calculation

Note: **denotes 5% significance level

The optimal lag is selected on the basis of Akaike Information Criteria (AIC)

As is shown in the table5.9, only the coefficient of lags of LNINDEX is significant at 5 percent level rejecting the null hypothesis of no Granger causality from infrastructure development (Index) to economic growth (GDP). On the other hand, the coefficient of lags of LNGDP is insignificant, indicating that there's no Granger causality from economic growth to infrastructure development (Index). Therefore, in the case of Pakistan, we conclude that there exists one-way causality from infrastructure development to economic growth.

5.2 The case of China

China is the leading country in Asian Infrastructure Investment Bank (AIIB) and one of the fast growing developing countries in the world for the past decades. Primarily dependent on investment, China sustained high economic growth, export and manufacture which might benefit from intensive development of infrastructure stock in urban areas or even in parts of rural areas. In this context, the role of explanatory variables such as investment, labor force, infrastructure and official development aid in promoting economic growth in China will be discussed on the basis of empirical results

In the case of China, the data of private capital (investment) is unavailable according to World Bank database. Therefore, gross capital formation (% of GDP) is used instead of separating investment into public capital (public investment) and private capital (private investment). Also, the same situation happens in the case of Indonesia.

The following two tables provide the ADF test and KPSS results of all the model variables. From the test results, we can safely conclude that no I(2) variables exist in the ARDL model and all the variables are mixed order of integration in I(0) and I(1).

Table 5.10 ADF test for unit roots (China)

Variables	ADF Test		Conclusion
	Level	1ST difference	
LNGDP	-1.27	-3.92	I(1)
LNINV	-0.07	-4.13 **	I(1)
LNLF	-5.67	---	I(0)
LNODA	-3.00	-4.52 **	I(1)
LNINDEX	-3.91 **	---	I(0)
LNEODB	-2.06	-3.38*	I(1)

Source: Author's Calculation

Note: *and**denote significance at 10% and 5% level

Table 5.11 KPSS test for unit roots (China)

Variables	KPSS Test	Conclusion
	Level	
LNGDP	0.14 *	I(0)
LNINV	0.15**	I(0)
LNLF	0.17 **	I(0)
LNODA	0.07*	I(0)
LNINDEX	0.07*	I(0)
LNEODB	0.19**	I(0)

Source: Author's calculation

∗and ∗∗ denote significance at 10% level and 5% level, respectively

The optimal lag and its corresponding ARDL model of error correction version can be specified as follows

$$\Delta LnGDP_t = \alpha + \delta_{11}\Delta LnGDP_{t-1} + \delta_{22}\Delta LnLF_{t-2} + \delta_{32}\Delta LnINV_{t-2} + \delta_{40}\Delta LnIndex_t + \delta_{41}\Delta LnIndex_{t-1} + \delta_{42}\Delta LnIndex_{t-2} + \delta_{51}\Delta LnODA_{t-1} + \delta_{61}\Delta LnEODB_{t-1} + \beta_1 LnGDP_{t-1} + \beta_2 LnLF_{t-1} + \beta_3 LnINV_{t-1} + \beta_4 LnIndex_{t-1} + \beta_5 LnODA_{t-1} + \beta_6 LnEODB_{t-1} + \mu_t \quad (10)$$

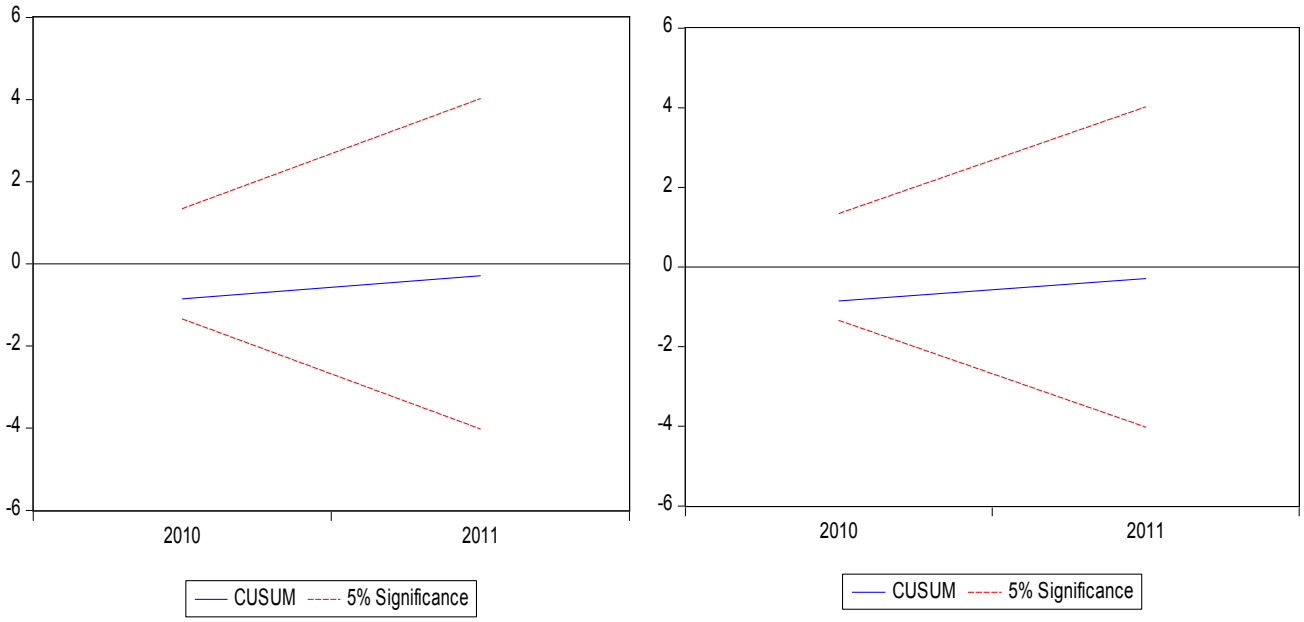
The following table concludes the test results of serial correlation LM test, Ramsey RESET test, Jarque-Bera Normality test and Heteroskedasticity Test with ARCH Method and the figure 5.2 plots the stability test CUSUM and CUSUM of square of the model. The results of all the test confirm the validity and suitability of the model.

Table 5.12 Diagnostic test results for ARDL Model
(China)

Test	Test statistics	Probability Value	Conclusion
Serial correlation LM test	79.55	0.07	Cannot reject null hypothesis : No serial correlation
Ramsey RESET Test	2.25	0.37	Cannot reject null hypothesis: Homoskedasticity
Heteroskedasticity Test ARCH method	3.43	0.085	Cannot reject null hypothesis: No heteroskedasticity
Normality Test	0.51	0.77	Cannot reject null hypothesis: Normally distributed

Source: Author's Calculation

Figure 5.2 Plot of CUSUM and CUSUM square of ARDL Model (China)



Source: Author's Calculation

The table 5.12 presents the F statistics of ARDL bound test and compares with Narayan (2004, p. 1988) and Pesaran et al. (2001,p. 300) . From the table 5.13, we can clearly find that statistic value far exceeds both Pesarn and Narayan's upper bound critical value at 1% significance level, indicating that the long run relationship surely exists between variables and offering foundation for estimation of long-run coefficients. The table 5.13 estimates the long run coefficients of variables in the case of China

Table 5.13 Bound test results for cointegration
(China)

Test statistics	Value	df	P Value
F statistic	626.97	(5,1)	0.0303
Chi-Square	3134.85	5	0.0000
Critical values extracted from Narayan (2004, p. 1988) Upper Bound Value in the case of intercept and no trend			
	I(0)	I(1)	
1% 5% 10%	4.768 3.353 2.752	6.670 4.774 3.994	
Critical values extracted from Pesaran et al. (2001,p. 300) Upper Bound Value in the case of intercept and no trend			
	I(0)	I(1)	
1% 5% 10%	3.74 2.86 2.45	5.06 4.01 3.52	

Source: Author's Calculation

Table 5.14 Estimated long run coefficients of Variables (China)

Dependent Variable : LNGDP				
Variables	Coefficient	Std.Error	t-Statistic	P Value
Constant	-27.88457	23.57540	-1.182783	0.2581
LNINV	0.513648	0.119999	4.280444	0.0009
LNLF	0.681599	1.191686	0.571962	0.5771
LNODA	0.003817	0.058444	0.065318	0.9489
LNINDEX	0.414426	0.142292	2.912507	0.0121
LNEODB	0.480930	0.252231	1.906707	0.0789

Source: Author's Calculation

As indicated in the table, all the coefficients except official development aid and labor force are significant in the long run. The coefficients of investment and infrastructure stock are significant at 1% level and infrastructure stock is significant at 5% level. However, in the long run, the official development aid has little effect on the economic growth for the case of China in the past two decades. As is shown in the table, the government expenditure in public sector, especially in infrastructure stock might be the determinant factor in promoting economic growth in China for the past 20 years and also the favorable level of business environment for investment is also important for economic growth in China.

Next, as mentioned in the previous context, we need to make sure the direction of causality between infrastructure and economic growth using granger causality test. The first step is to test the existence of cointegrating vectors in the two variables using Johansen Cointegrating test. According to the test result in the following table, the corresponding method for Granger causality test will be decided. The test result is listed in the table as follows

Table 5.15 Results for Johansen test for cointegrating vectors (China)

Test type	Trace/Max Eigenvalue	Trace/ Max-Eigen statistic	0.05 Critical Value	P value
Trace				
None*	0.628077	16.83899	18.39771	0.0815
At most 1	0.001458	0.024810	3.841466	0.8748
Max Eigenvalue				
None *	0.628077	16.81418	17.14769	0.0558
At most 1	0.001458	0.024810	3.841466	0.8748

Source: Author's calculation

Note

The test assumes a linear deterministic trend in the data.

The lag length selected by Schwarz-Bayesian Information Criterion (SBIC) for the VAR analysis is two for model

After Johansen cointegrating test, we find that both trace and max eigenvalue tests denote the rejection of the null hypothesis of no cointegrating vectors and indicate there exists at most 1 cointegrating vectors among variables. Therefore, the Granger Causality test using VECM method is the appropriate way to check the direction of causality. The following two tables show the results of Granger Causality test with VECM method.

Table 5.16 Regression results for VECM Model with dependent variables GDP (China)

Dependent Variable : D(LNGDP)				
Variables	Coefficient	Std. Error	t statistic	P value
Lagged ECM Term	-0.053143	0.023393	-2.271768	0.0442
D(LNGDP(-1))	0.661980	0.210276	3.148147	0.0093
D(LNGDP(-2))	-0.371941	0.187141	-1.987488	0.0723
D(LNINDEX(-1))	0.035912	0.137692	0.260817	0.7991
D(LNINDEX(-2))	0.063397	0.136408	0.464759	0.6512
Constant	0.087310	0.036833	2.370390	0.0371

Source: Author's Calculation

Table 5.17 Regression results for VECM Model with dependent variable Infrastructure index (China)

Dependent Variable : D(LNINDEX)				
Variables	Coefficient	Std. Error	t statistic	P value
Lagged ECM Term	0.019118	0.044507	0.429544	0.6758
D(LNGDP(-1))	0.604268	0.400063	1.510432	0.1591
D(LNGDP(-2))	-0.496968	0.356047	-1.395793	0.1903
D(LNINDEX(-1))	-0.284316	0.261967	-1.085313	0.3010
D(LNINDEX(-2))	-0.307986	0.259524	-1.186731	0.2603
Constant	0.167225	0.070078	2.386274	0.0361

Source: Author's Calculation

In order to test the long run and short run Granger causality between infrastructure stock and economic growth, the Wald test (F statistics) for the joint significance of coefficients of lags of LNINDEX or LNGDP to confirm the short run causality. T statistics for the significance of coefficients of lagged ECM term is also required to check the long run causality. The following table concludes the Wald test and t test results for the coefficient significance in Granger causality.

Table 5.18 Results of Granger causality test hhh(China)

Causality between Infrastructure and GDP			
Dependent Variable	$\sum_{i=1}^{p} \Delta LNINDEX_{t-i}$	$\sum_{i=1}^{p} \Delta LNGDP_{t-i}$	Lagged ECM term
	$\sum_{i=1}^{p} \gamma_i = 0$: F-Statistics (P value)	$\sum_{i=1}^{p} \gamma_i = 0$: F-Statistics (P value)	$\pi_{x,y} = 0$ T statistics (P value)
D(LNGDP)	0.122584 (0.8858)		-0.053143 (0.0442)
D(LNINDEX)		1.529670 (0.2593)	0.019118 (0.6758)

Source: Author's Calculation

As indicated in the table, lagged ECM term is significant at nearly 5% rejecting null hypothesis of no granger causality from infrastructure to economic growth and indicating long run granger causality between two variables. At the same time, insignificant coefficients of lags of $\Delta LNGDP_{t-i}$ and lagged ECM term show that there exists no granger causality from economic growth to infrastructure both in the short run and long run.

5.3 Empirical results of other countries

This section briefly concludes the long-run relationship between economic variables in three other Asian countries, namely, India, Indonesia, and Malaysia. For simplicity, only the optimal lag selection for the ARDL model, long-run coefficient estimation and other highly related test results will be provided in this part. This part begins with the ADF and KPSS test results for the unit roots for each of countries.

First, all the three countries are qualified for ARDL model since no I(2) variables shown from two test results for the three countries. The following table shows the ADF test results for the variables in all the three countries.

Table 5.19 ADF test for unit roots
(India, Indonesia and Malaysia)

ADF test results			
	India	Indonesia	Malaysia
Variables			
LNGDP	I(1)	I(1)	I(1)**
LNKPUBT (LNINV)	I(1)*	I(1)	I(1)
LNKPVT	I(1)**	-	I(1)**
LNLF	I(1)	I(1)	I(1)
LNODA	I(1)	I(0)	I(0)
LNINDEX	I(1)*	I(1)	I(1)
LNEODB	I(0)	I(1)	I(0)

Source: Author's calculation

Note:*and **denote significance at 10% and 5% level.

Table 5.20 KPSS test for Unit roots
(India, Indonesia, Malaysia)

KPSS test results			
	India	Indonesia	Malaysia
Variables			
LNGDP	I(0)**	I(0)**	I(0)**
LNKPUBT	I(0)*	I(0)	I(1)
LNKPVT	I(0)*	-	I(0)*
LNLF	I(0)*	I(0)	I(0)*
LNODA	I(0)**	I(0)	I(1)
LNINDEX	I(0)**	I(0)*	I(0)**
LNEODB	I(0)**	I(0)**	I(0)*

Source: Author's calculation

Note: *and **denote significance at 10% and 5% level.

After selecting the optimal lag, the ARDL error correction version for the three countries are specified in the following table with the minimum values of Akaike Information criteria and the models for the three countries pass all the diagnostic test, such as serial correlation LM test, heteroskedasticity with ARCH methodology, Normality test and Ramsey RESET Test. At the same time, CUSUM test results show the stability for the three models. The following table concludes the optimal lag selection and the corresponding error correction version of ARDL model.

The following table concludes the bounds testing results for the three countries and provides foundation for long run coefficients estimation in the table.

Table 5.21 Bound test results for cointegration
(India, Indonesia and Malaysia)

Countries	F statistic (P value)	df
India	286.6963 (0.0454)	(7,1)
Indonesia	61.10471 (0.0982)	(7,1)
Malaysia	274.4435 (0.0464)	(7,1)

Source: Author's calculation

Table 5.22 Estimated long run coefficients of variables
(India, Indonesia and Malaysia)

Dependent Variable: LNGDP			
	India	Indonesia	Malaysia
Variables	Coefficient (P value)	Coefficient (P value)	Coefficient (P value)
LNKPUBT (LNINV)	0.174500 (0.2467)	0.333765[11] (0.3593)	0.196305 (0.4998)
LNKPVT	0.404954 (0.0495)	_	0.198571 (0.0993
LNLF	2.334196 (0.0506)	2.02812 (0.0088)	1.888119 (0.0126)
LNODA	0.318132 (0.0333)	1.176595 (0.0609)	0.161072 (0.0384)
LNINDEX	0.682903 (0.0343)	0.802163 (0.0079)	0.173309 (0.7786)
LNEODB	0.575147 (0.1959)	1.681062 (0.1323)	3.845749 (0.1307)
Constant	-47.41626 (0.0232)	-39.92268 (0.03593)	-36.5195 (0.0004)

Source: Author's calculation

As indicated in the table 5.22, all the variables have positive effect on economic growth in the long run for the three countries. For the case of India, almost all the variables are significance at 5% except public investment and ease of doing business

[11] The data of private capital is not available from the World Bank database. Therefore, the gross fixed capital formation (% of GDP) is used to define the whole investment, including public capital and private capital instead of separating

index. For the case of Indonesia, both coefficients of ODA and infrastructure stock are significant in the long run. For the case of Malaysia, the coefficient of infrastructure stock is insignificant but ODA is significant. At the same time, labor force has the relatively high significance among variables in the three countries

The following table 5.23 presents results the Johansen cointergrating and the corresponding methodology. And the table 5.24 -5.26 show the F statistics to make sure the direction of effect between infrastructure stock and economic growth for the country India, Indonesia and Malaysia.

Table 5.23 Johansen test results for cointergrating vectors
(India, Indonesia, Malaysia)

Countries	Test results	Methodology
India	One integrating vector	Granger causality test with VECM
Indonesia	No integrating vectors	Granger causality test with VAR
Malaysia	No integrating vectors	Granger causality test with VAR

Source: Author's calculation

Table 5.24 Results of Granger Causality test between infrastructure and GDP (India)

Causality between Infrastructure and GDP			
Dependent Variable	$\sum_{i=1}^{p} \Delta LNINDEX_{t-i}$	$\sum_{i=1}^{p} \Delta LNGDP_{t-i}$	Lagged ECM term
	$\sum_{i=1}^{p} \gamma_i = 0$: F-Statistics (P value)	$\sum_{i=1}^{p} \gamma_i = 0$: F-Statistics (P value)	$\pi_{x,y} = 0$ T statistics (P value)
D(LNGDP)	0.641004 (0.5454)		-0.833985 (0.1008)
D(LNINDEX)		0.240749 (0.7901)	0.363213 (0.5335)
Conclusion: There exists one way granger causality between infrastructure and economic growth and infrastructure stock granger causes economic growth in the long run but no short-run relationship. .			

Source: Author's calculation

Table 5.25 Results of Granger Causality test between infrastructure and GDP (Indonesia)

Causality between Infrastructure and GDP (Indonesia)		
Dependent variables	$\sum_{i=1}^{p} LNINDEX_{t-i}$	$\sum_{i=1}^{p} LNGDP_{t-i}$
	$\sum_{i=1}^{p} \beta_i = 0$: F-statistics (P value)	$\sum_{i=1}^{p} \beta_i = 0$: F-statistics (P value)
LNGDP	1.036859 (0.3821)	
LNINDEX		5.487190 (0.0187)
Conclusion There exists one way granger causality between infrastructure and economic growth and economic growth granger causes infrastructure stock.		

Source: Author's calculation

Table 5.26 Results of Granger Causality test between infrastructure and GDP (Malaysia)

Causality between Infrastructure and GDP (Malaysia)		
Dependent variables	$\sum_{i=1}^{p} LNINDEX_{t-i}$	$\sum_{i=1}^{p} LNGDP_{t-i}$
	$\sum_{i=1}^{p} \beta_i = 0$: F-statistics (P value)	$\sum_{i=1}^{p} \beta_i = 0$: F-statistics (P value)
LNGDP	1.619939 (0.2354)	
LNINDEX		3.3511990 (0.0670)
Conclusion There exists one way granger causality between infrastructure and economic growth and economic growth granger causes infrastructure stock at 10% significance level.		

Source: Author's calculation

5.4 Empirical Results analysis

In order to well analyze the significant role of AIIB, the following table concludes empirical results of the top five countries in terms of aid demand. The table provides the major conclusions of long-run relationship between variables for each of five countries, especially, the two concerned relationship: infrastructure development and economic growth and ODA and economic growth. The table5.27 also presents the granger causality between infrastructure development and economic growth in five countries.

Table 5.27 Conclusions of key interests of the thesis for five selected countries

	Key interests		
	Long run coefficients between infrastructure development and GDP per capita	Long run coefficients between ODA and GDP per capita	Granger causality between infrastructure development and GDP per capita
Countries	Coefficient (P value)	Coefficient (P value)	Conclusion
China	0.414426 (0.0121)	0.003817 (0.9489)	One way direction Infrastructure development granger causes economic growth
India	0.682903 (0.0343)	0.318132 (0.0333)	One way direction Infrastructure development granger causes infrastructure development
Indonesia	0.802163 (0.0079)	0.318132 (0.0609)	One way direction Economic growth granger causes infrastructure development
Malaysia	0.173309 (0.7786)	0.161072 (0.0384)	One way direction Economic growth granger causes infrastructure development
Pakistan	0.4598 (0.3476)	0.549011 (0.0025)	One way direction Infrastructure development granger causes economic growth

Source: Author's Calculation

From the table5.27, we can find that all the coefficients of variables interested are positive for five countries, implying that infrastructure development and official development aid indeed promote economic growth in the long run. The thesis also introduces the Granger causality test to check the causality direction between

infrastructure development and economic growth. From the table, all of the countries have the one way direction of causality. Infrastructure development causes the economic growth for China, Pakistan and India while GDP growth causes infrastructure development for the other two countries.

To conclude, the nonnegative coefficients of infrastructure index and ODA indicate that AIIB potentially exerts a positive impact on its top five recipients in the long run after the official development aid or other development fund for the infrastructure projects are allocated. The significance degree of key interested variables implies that at least one factor (either ODA or Infrastructure development) plays key role in facilitating the economic growth in five countries. AIIB, as a complementary institution to ADB, through addressing the financing problem of ever growing infrastructure needs in Asia, indeed benefits major recipient countries. Although no further research on other small recipient countries, some literature has shown the positive long run relationship between infrastructure, ODA and economic growth, such as Vietnam and Thailand. For example, Nguyen Xuan Thanh and David Dapice state in their paper " Vietnam's infrastructure constraints" that over the past twelve years, total infrastructure investment has accounted for more than 10 percent of GDP on average, putting Vietnam ahead of most East Asian economies. ADB forecasted in Asian Development outlook 2015 that Thailand is expected to lift GDP growth to 3.6% in 2015 and 4.1% next year after public fixed investment rises in 2015 for the approved infrastructure program that includes $95 billion in investments over 8 years in railways, roads, ports, airports, and special economic zones. From that, safe conclusions can be made that AIIB might also benefit other smaller developing countries in Asia.

6. Suggestions for AIIB aid allocation criteria

This chapter introduces the widely used aid allocation system---performance-based aid allocation (PBA) and its criteria for selectivity adopted by most international monetary institutions, such as World Bank, Africa Development Bank and Asian Development Bank. Then, the possible suggestions for proper modifications will be given to the aid allocation criteria for AIIB on the basis of PBA. The modifications aim at improving the effectiveness and distinguishing AIIB with other multilateral lending institutions based on its "specialist" on infrastructure projects.

6.1 Brief review of Performance-based Allocation System (PBA)

Performance-based Allocation System is the most explicit and commonly used aid allocation system among international monetary institutions. Initially introduced by World Bank for allocation of International Development Association (IDA) funds, performance-based Allocation System is influential and replicated in other multilateral development banks as well, such as Africa Development Bank (AFDB) and Asian Development Bank (ADB).

The Performance-based Allocation System attempts to combine three principles, namely, effectiveness, equity and transparency and ranks the developing countries according to their priorities for the development aids. The PBA formula is a weighted geometric function of the composite country performance rating, per capita income and population. The country performance rating is assessed annually using the Country Policy and Institutional assessment rating (CPIA) and is the most determined part, implying the high weighting in the PBA system. The CPIA aims to assess the country policy and institutional framework and has 16 indicators of four equally weighted clusters 1) Macroeconomic Management 2) Structural policies 3) Policies for social inclusion and equity 4) Public sector Management and institutions. The 16

indicators and 4 clusters are shown in the following figure provided by World Bank IDA's performance-based allocation system.

Figure 6.1 16 Indicators in 4 clusters of CPIA for IDA

A. Economic Management (Average scores of 1-3)
1. Macroeconomic Management
2. Fiscal Policy
3. Debt Policy
B. Structural Policies (Average scores of 1-3)
4. Trade
5. Financial Sector
6. Business Regulatory Environment
C. Policies for Social Inclusion (Average scores of 1-5)
7. Gender Equality
8. Equity of Public Resource Use
9. Building Human Resources
10. Social Protection and Labor
11. Policies and Institutions for Environmental Sustainability
D. Public Sector Management and Institutions(Average scores of 1-5)
12. Property Rights and Rule-based Governance
13. Quality of Budgetary and Financial Management
14. Efficiency of Revenue Mobilization
15. Quality of Public Administration
16. Transparency, Accountability, and Corruption in the Public Sector

Source: IDA. 2006. Post Conflict Performance Indictors (PCPIs) 2006. Washington, DC.

In addition to CPIA, Portfolio Performance Rating (PPR) capturing the quality of management of IDA's projects and programs, enters the calculation of the CPR as well. The PPR follows major three steps. First step is the measurement and identification of problem projects using specific criteria differed among institutions. Then, the problem projects are adjusted for the average age of the projects since younger portfolio are less vulnerable to risk and take a longer time to be exposed. Principally, for each year that a country's portfolio is younger than the average age, the percentage of projects at risk is increased by five percent. Final step is the conversion percentage of problem projects into rating scale.

The country rating performance formula for IDA's fund resources of World Bank is specified as follows

$$\text{Country Performance Rating} = 0.24 * CPIA_{A-C} + 0.68 * CPIA_{D} + 0.08 * PPR \qquad (11)$$

where $CPIA_{A-C}$ is the average ratings of CPIA clusters A to C, $CPIA_{D}$ is the rating of CPIA cluster D, and the PPR reflects the health of the IDA projects portfolio, as measured by the percentage of problem projects in each country However, the country rating performance formula is not necessarily specified the same, different institutions define different formula which suits for the purposes and structure of the development fund. For example, Asian Development Bank adopts different formula as follows

$$\text{Country Performance Rating} = (CPIA_{A-C})^{0.7} * (CPIA_{D})^{1.0} * (PPR)^{0.3} \qquad (12)$$

While country performance is the main determinant in core PBA system, the country needs which are measured by GNI per capita and population still remains to give final rating. These two factors have contrary effects on the aid allocation. Specifically, the increase in population results in increase in aid allocation while countries with lower GNI per capita receives theoretically higher aid allocation. The final PBA score for country i is calculated in the following formula according to the IDA aid allocation of World Bank

$$PBA_i = \frac{CPR_i^5 * POP_i * (GNIpercapita)_i^{-0.125}}{\sum_{i=1}^{N} CPR_i^5 * POP_i * (GNIpercapita)_i^{-0.125}} \qquad (13)$$

However, the weighting of three variables in PBA calculation can be different among institutions. For example, in ADB case, country performance rating is given weighting 2 instead of 5, together with GNI per capita -0.25 and population 0.6 instead of -0.125and 1 in the World Bank case. The PBA calculation is defined as

following formula in the ADB case

$$PBA_i = \frac{CPR_i^{2.00} * POP_i^{0.6} * GNIpercapita_i^{-0.25}}{\sum_{i=1}^{N} CPR_i^{2.00} * POP_i^{0.6} * GNIpercapita_i^{-0.25}} \quad (14)$$

After figuring out the PBA of each country (also called country allocation share in the context of ADB case), the final lending level is then calculated by multiplying the expected Development Fund commitment authority by its country allocation share (PBA).

Also, PBA system itself has undergone several historical changes in its calculation methodology, especially in the selection of weighting values both in whole PBA function and CPR function. The PBA system has evolved in recent two decades though the no significant changes in basic methodology but the weighting value and elements in PBA have changed gradually and the existence of different calculations is either due to the improving estimates of weighting values or more suitability of different situations for aid allocation.

6.2 Possible suggestions for AIIB aid allocation

Although Asian Infrastructure Investment Bank (AIIB) is a newly-established multilateral development bank with no further strategy and specific methodology for aid allocation, the Bank's foundation is built on the lessons of experience of existing MDBs and the private sectors. Therefore, it is reasonable to reckon that the PBA system with suitable modification can be still adopted with highest probability. However, traditional framework of PBA system that is similar to other institutions should be modified according to the nature, function and objective of AIIB.

6.2.1 Consideration of Infrastructure Factors

The first modification I suggest to the AIIB aid allocation method based on PBA system is the consideration of infrastructure factors. The AIIB which focuses on the development of infrastructure and other productive sectors in Asia takes special consideration into the infrastructure projects and public sector productivity. Therefore, the correlation between existing infrastructure and economic growth of the recipient countries should be taken into account. However, the traditional PBA system gives little emphasis on the infrastructure factors in country performance rating.

The CPIA offers more weights on policy and management rating and has no clusters relevant to infrastructure-growth relationship. Therefore, it will be better and more suitable to add one more cluster which presents the long-run relationship between infrastructure and economic growth for each recipients. The measurement of the infrastructure-growth relationship can be derived from the coefficients[12] calculated through empirical ARDL model mentioned in the chapter 4. The countries can be divided into several groups and ranked according to their degree of correlation (between infrastructure and economic growth). The highest rating scores are given to those countries with closer and positive long –run correlation, then second highest rating scores are given to second country group and so on. This cluster implies that those countries with higher rating score might function better on infrastructure projects if the aid from AIIB is received. When calculating the country performance rating, this cluster should be offered proper weighting. However, the weighting value needs to be researched and confirmed will not be discussed in the thesis.

6.2.2 The modification in portfolio performance rating

The basic methodology for portfolio performance rating is to calculate the percentage of problem projects with adjustment of average age of the projects. The basic

[12] The coefficients calculated in Chapter 4 might be re-estimated after AIIB starts its work according to the real situation in the recipient countries at that time

methodology takes into consideration of all the problem projects while in the AIIB case, the funded projects are almost infrastructure projects. Therefore, the basic methodology might be less accurate and lead to biased results which are either magnify or narrow the effects of the portfolio performance rating on the country performance rating in AIIB case. Therefore, the second modification of PBA system for AIIB is to calculate the percentage of infrastructure projects at risk to the aggregate problem projects after adjustment of average age as well. Then, the average scores for these two indicators (or specific weighting values) serve as final value of portfolio performance rating.

6.2.3 The modification in the governance rating

The final modification that AIIB can take into consideration is to give more scores on the two indicators---Quality of public administration and Transparency, accountability and corruption in the public sector instead of taking average scores of all the five indicators in the cluster--- Governance rating. Traditionally, public sectors or governments of developing countries appropriated all aspects of infrastructure, with private participation taking very little responsibility, that is to say, the performance of public sectors plays a more important in aid effectiveness. Therefore, it's reasonable to consider to calculate governance rating with high weight in these two indicators.

7. The challenges of AIIB and possible suggestions

The previous chapters discuss the important role of Asian Infrastructure Investment Bank (AIIB) in promoting the economic growth through infrastructure projects in the long term. However, AIIB is criticized and questioned by foreign media and some economists, especially US media for its overlapping function with Asian Development Bank (ADB), potential corruption, bad consequences on environment.

7.1 Overlapping functions with ADB

Although AIIB was initially positioned as the complementary institution for ADB, it still has some similar functions with AIIB, especially the allocation of loans from development fund. These similarities have raised the criticism for resource waste in physical and human capital. It might be meaningless to establish a multilateral institution in such a big effort that has the similar function with ADB and it seems to serve more as a political instrument for the leading country, China. However, proponents of AIIB have stated that it's reasonable to have AIIB because the huge infrastructure financing needs facing by Asian developing countries and it might be impossible to cater the huge financing needs through only one institution.

Therefore, the overlapping problems will remain a challenge for AIIB if the relevant focus and function are highly similar. In order to address the problem, I have following two possible suggestions. First, AIIB and ADB could focus on different types of recipients for aid allocation in infrastructure projects. For example, AIIB can focus on middle-income Asian developing countries while ADB lays its focus on relatively low-income countries. The two institutions have the different standard of country performance assessment based on their focus when allocating loans for infrastructure projects.

Second, AIIB and ADB could focus on different contents of infrastructure projects.

For instance, as mentioned by AIIB, its major focuses of infrastructure projects are energy and power, transportation and telecommunications, rural infrastructure and agriculture development, water supply and sanitation, environmental protection, urban development and logistics. Therefore, it's wise and efficient for ADB to have divergent focuses on other infrastructure contents. To facilitate strong collaboration between AIIB and ADB, the suggestions mentioned could be taken into consideration.

7.2 Potential corruption in AIIB

As a multilateral lending institution, it might unavoidably face the problem of potential corruption and lack of openness of its operations, especially AIIB, a newly established institution with membership in Asia which most rank almost last in aid transparency index in two consecutive years 2013 and 2014. Therefore, many critics concerned that the aid and loan provided by AIIB might not promote infrastructure development and economic growth in recipients for the reason of corruption. At the same time, the problems of corruption not only exist in recipient countries but also in the AIIB itself. According to U.S. China, as the leading country in AIIB, has the nearly 27% voting right and it's worrisome that China ranking dead last in aid transparency index might convict corruption and vote for its own interest.

Regarding two challenges mentioned, introducing the monitoring party, giving high weighting for transparency, accountability, corruption index in country performance assessment and tracking the aid utilization might be a good help. For the problem of recipients' corruption, the country performance assessment should give the transparency index high weighting instead of averaging 6 indicators of Public Sector Management and Institutions. The weight can be adjusted by the historical average ranking of transparency index of each country, that is, higher ranking with lower weighting. However, the minimum weight for this indicator should at least larger than others. At the same time, AIIB should track the process of the infrastructure projects and the utlization of the aid after loaning for the recipients. On the other hand, for the

problem of corruption in AIIB itself, third monitoring party might be the remedy. An independent third party or the AIIB member except China can be qualified for the monitoring party to prevent corruption and maximize openness of operations.

7.3 Problem of green environment

Although AIIB states repeatedly that its modus operandi will be lean, clean and green with green representing its respect for the environment, many criticism still questions the credibility of its statement of environment protection since the large scale of infrastructure development will definitely cause environment deterioration. Concerns about the credibility of AIIB's sustainable lending due to the environmental issues grow as fast as. The solutions to environmental issues are to some extent equivalent to address the problems of unsustainable development in developing countries.

The most important way to reduce the negative consequences on environment is to grow public awareness and social responsibility in developing countries. AIIB's leadership should encourage companies, especially state-owned enterprises, to engage in more corporate social responsibility when conducting the infrastructure projects. For example, policy incentives such as lower interest rate for loan if green material use. The leadership could also organize conferences about green and latest technology and environmental protection to make recipients more exposure to the best practices of their foreign counterparts.

In spite of several challenges facing AIIB, it is still a reality that AIIB gets a big toehold in promoting economic growth in Asian developing countries. The newly-born AIIB should keep pace in new investment trend and take social responsibility to well serve its perspective members and it has a long way to go.

8. Limitation and further research

Although the thesis confirms the important role of AIIB on infrastructure-growth of major Asian developing countries, it still has some limitations and leaves possibilities for modification and further research. First, the thesis only provides the empirical results of five major Asian developing countries and no detailed research for other smaller countries, such as Vietnam, the Philippines, Bangladesh and Thailand. Therefore, critics might arise that it's arbitrary to conclude the positive role of AIIB without giving the detailed research of other small countries. These critics might point out the crowding out effect of aid, implying that the big countries will crowd out the aid for the small countries since the fixed aid amount and lead to negative role of AIIB on Asian developing countries as whole.

The technical problems of the ARDL model are also open to criticize. First, the econometric model in my thesis doesn't take into consideration the policy factors which are emphasized in the previous aid-growth literature and might be doubted for biased empirical results. For further improvement, CPIA can be included as a policy index variable in my ARDL model. Also, since the Ease of doing business mentioned in the thesis can be regarded as the contributor to the efficiency of private capital, the inclusion of private capital and Ease of doing business index might lead to biased estimates and the double accounting problems need to be addressed. Second, the sample size is relatively small and probably gives wrong judgment of diagnostic tests and biased empirical results as well. However, the first limitation is justified since the key focus of the thesis is the sign of long-run coefficient between infrastructure and growth and the influence of policy factors is not that big enough to change the sign of coefficient between aid and growth. Also, some literature denies the influence of policy factors in aid-growth relationship. The second limitation can be explained by the unavailable data source to support the longer time period.

The third limitation is regarding the aid allocation criteria. The thesis only points out that it's reasonable and suitable to take into account the infrastructure-growth relationship when determining the proportion of aid allocation. The thesis gives a possible measurement of the infrastructure-growth relationship in aid allocation criteria but doesn't provide quantitative proof for the practicality of the measurement. No concrete implementation scheme with accurate weights in country performance assessment are offered. The concrete implementation can be left for further research and discussion. And the same situation happens in the second and third suggestions in the aid allocation criteria for AIIB discussed in the Chapter 6.

Finally, the net ODA received is the measurement for the ODA in the model. However, the major responsibility of AIIB is to provide aid to promote infrastructure development in Asian development countries. In other words, the aid provided by AIIB is mainly for infrastructure use. The scope of ODA discussed in the thesis to some extent is broader than what is defined from AIIB's perspective. In other words, the ODA data I used in the model can capture more functions, such as poverty alleviation and gender equity development that might result in either overestimated or underestimated AIIB's effects on economic growth. Specifically, if the most of aid is used as infrastructure historically, the coefficient of infrastructure index of one country will be underestimated, so as the effect of AIIB on its economic growth and vice versa.

To conclude, the thesis is still open to many modifications both technically and academically. Therefore, further research is required to address the limitations, from which the complementary results might be derived. In spite of some limitations existing in the thesis, the thesis still serve as a bridge between previous theoretical research on infrastructure and aid-growth relationship and practical issue, newly-established AIIB. At the same time, the thesis also provides a foundation for further research for AIIB.

9. Conclusion

To reduce the funding gap in infrastructure projects, AIIB was established in the end of 2013 to complement ADB and well serve Asian developing countries. Primarily, the thesis mainly discusses the newly-established Asian Infrastructure Investment Bank (AIIB) and its role on economic growth of Asian developing countries. In the first part, the thesis compares AIIB with other multilateral monetary institutions, such as World Bank and Asian Development Bank (ADB) and discusses the functions of AIIB to embody its irreplaceable position

In the second part, empirical analysis and econometric method are applied to find out the potential role of AIIB in promoting economic growth in Asian developing countries by understanding the long-run relationship between infrastructure, aid and economic growth. The empirical results clearly show that both infrastructure and official development aid have positive effect on economic growth in the top five selected countries in Asia based on their demand for aid. However, the significance level differs between countries. For China, the infrastructure development facilitates economic growth significantly in the long run while official development aid shows less significance in both two countries. For Malaysia and Pakistan, the case is totally different. Infrastructure development has insignificant role in the long run. For the other three countries, both infrastructure development and ODA are important for economic growth. From the empirical results, we can conclude that AIIB might have a potentially positive effect on economic growth in Asian developing countries since at least one of the coefficients of key variables (ODA and Infrastructure) are significant in these five countries.

In the third part, the modification of aid allocation is suggested to distinguish AIIB with ADB and the challenges of AIIB are pointed out with possible suggestions. The thesis suggests that the country performance assessment which determines the country

rating for aid should take into consideration of infrastructure-growth relationship. To be specific, for a member country, the more related with infrastructure development and economic growth, the more score it gets, in a result, the more possibility for more aid. Although AIIB has a positive role in promoting economic growth in Asian developing countries, it still face up to challenges. AIIB is criticized from its start-up for potential corruption, bad consequences on environment and overlapping function with ADB. The thesis also gives own suggestions for possible solutions according to three challenges. In the final part of the thesis, the limitations of the thesis both technically and academically are pointed out and open to further research.

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Appendix 1

The table A1.1—A1.4 show the eigenvalues and variance explained by principal components for four countries expect China

Table A 1.1 eigenvalues and variance (India)

Infrastructure Index for India			
Principal components	Values	% of Variance	Cumulative values
1	5.444086	0.9073	0.9073
2	0.318052	0.053	0.9604
3	0.199271	0.0332	0.9936
4	0.030466	0.0051	0.9986
5	0.005682	0.0009	0.9996
6	0.002442	0.0004	1

Source: Author's Calculation

Table A 1.2 eigenvalues and variance (Indonesia)

Infrastructure Index for Indonesia			
Principal components	Values	% of Variance	Cumulative values
1	4,434421	0.7391	0.7391
2	1.112552	0.1854	0.9245
3	0.349956	0.0583	0.9828
4	0.0092360	0.0154	0.9982
5	0.009651	0.0016	0.9998
6	0.001061	0.0002	1

Source: Author's Calculation

Table A 1.3 Eigen values and variance (Malaysia)

Infrastructure Index for Malaysia			
Principal components	Values	% of Variance	Cumulative values
1	4.483165	0.7472	0.7472
2	1.006810	0.1678	0.9150
3	0.361186	0.0602	0.9752
4	0.117775	0.0196	0.9948
5	0.024855	0.0041	0.9990
6	0.006209	0.0010	1

Source: Author's calculation

Table A 1.4 Eigen values and variance (Pakistan)

Infrastructure Index for Pakistan			
Principal components	Values	% of Variance	Cumulative values
1	3.789295	0.6315	0.6315
2	1.393735	0.2323	0.8638
3	0.564911	0.0942	0.9580
4	0.150003	0.0250	0.9830
5	0.085802	0.0143	0.9973
6	0.016254	0.0027	1

Source: Author's calculation

The table A1.5-1.8 present factor loading of original values of six indicators for four countries.

Table A1.5 Factors loading of original values (India)

India	
Infrastructure Variables	Loadings
Air transport registered carrier departures, world	0.41662
Electricity Power consumption(KWh per capita)	0.425749
Fixed(wired)broadband subscriptions (per100 people)	0.408559
Improved water source, urban(%urban population with access)	0.399924
Mobile phone subscription (per 100 people)	0.408468
Rail Line (Total route-km)	0.389177

Table A1.6 Factors loading of original values (Indonesia)

Indonesia	
Infrastructure Variables	Loadings
Air transport registered carrier departures, world	0.387617
Electricity Power consumption(KWh per capita)	0.423389
Fixed(wired)broadband subscriptions (per100 people)	0.412522
Improved water source, urban(%urban population with access)	0.418022
Mobile phone subscription (per 100 people)	0.425651
Rail Line (Total route-km)	0.37998

Source: Author's calculation

Table A1.7 Factors loading of original values (Malaysia)

Malaysia	
Infrastructure Variables	Loadings
Air transport registered carrier departures, world	0.391867
Electricity Power consumption(KWh per capita)	0.447011
Fixed(wired)broadband subscriptions (per100 people)	0.461244
Improved water source, urban(%urban population with access)	0.339757
Mobile phone subscription (per 100 people)	0.456236
Rail Line (Total route-km)	0.332100

Source: Author's calculation

Table A1.8 Factors loading of original values (Pakistan)

Pakistan	
Infrastructure Variables	Loadings
Air transport registered carrier departures, world	0.455686
Electricity Power consumption(KWh per capita)	0.282285
Fixed(wired)broadband subscriptions (per100 people)	0.456687
Improved water source, urban(%urban population with access)	0.453417
Mobile phone subscription (per 100 people)	0.430203
Rail Line (Total route-km)	0.336809

Source: Author's calculation

Appendix 2

As mentioned previously, double counting problem might lead to coefficient bias in the regression because this method will provide for a larger coefficient on aid when investment also includes ODA. In the thesis, there are two sources of capital, namely, private and public investment. Here, the dependent variable, INV is the aggregration of public and private investment[13]. Therefore, we can address the problem by estimating the coefficient κ_2 through the following specified equation to exclude the effect of ODA on the public capital.

$$INV = \kappa_1 + \kappa_2 ODA \tag{15}$$

The basic investment mechanism regression model for a specific country i can be given as follows and $Kpub_i$ defines the public capital which excludes the official development aid.

$$L\mathrm{nINV}_{i,t} = \kappa_0 + \kappa_1 LnINV_{i,t-1} + \kappa_2 LnODA_{i,t} + \kappa_3 LnGDP_{i,t} + \kappa_4 LnCredit_{i,t} + \varepsilon_{i,t} \tag{16}$$

The following table presents the regression results for five countries. From the table, we can find that in all the five countries, official development aid affects investment positively but not always significantly. Only in the case of China, aid affects investment significantly. For other four countries, the coefficients are not significant However, it is still necessary to take the investment transmission mechanism. The following table 2.1-2.5 present the results of investment regression for the five countries.

[13] The used data here is the gross fixed capital formation (% of GDP)

Table A2.1 Results of investment regression (China)
Dependent Variable: LNINV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNODA	18.14703	5.293614	3.428098	0.0041
LNCREDIT	0.156873	0.051232	3.062033	0.0084
LNGDP	0.860516	0.348783	2.467193	0.0271
LNKPUB(-1)	0.347430	0.167210	2.077807	0.0566
C	-0.027077	0.104911	-0.258091	0.8001

R-squared	0.727623	Mean dependent var	0.437750
Adjusted R-squared	0.649801	S.D. dependent var	0.043995
S.E. of regression	0.026035	Akaike info criterion	-4.237802
Sum squared resid	0.009490	Schwarz criterion	-3.989266
Log likelihood	45.25912	Hannan-Quinn criter.	-4.195740
F-statistic	9.349825	Durbin-Watson stat	1.272222
Prob(F-statistic)	0.000678		

Source: Author's Calculation

Table A 2.2 Results of investment regression (India)
Dependent Variable: LNINV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.015923	0.049232	0.323437	0.7511
LNCREDIT	0.074420	0.078974	0.942339	0.3620
LNODA	8.600525	7.021521	1.224881	0.2408
LNGDP	0.154229	0.222336	0.693676	0.4992
LNINV(-1)	0.243436	0.347788	0.699956	0.4954

R-squared	0.418892	Mean dependent var	0.123820
Adjusted R-squared	0.252862	S.D. dependent var	0.021772
S.E. of regression	0.018819	Akaike info criterion	-4.886927
Sum squared resid	0.004958	Schwarz criterion	-4.638391
Log likelihood	51.42581	Hannan-Quinn criter.	-4.844865
F-statistic	2.522980	Durbin-Watson stat	1.814622
Prob(F-statistic)	0.087991		

Source: Author's Calculation

Table A2.3 Results of investment regression (Indonesia)
Dependent variables: LNINV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.043478	3.409831	-1.479099	0.1613
LNINV(-1)	0.608461	0.098459	6.179856	0.0000
LNODA	0.050730	0.043784	1.158639	0.2660
LNGDP	0.488132	0.264245	1.847271	0.0859
LNCREDIT	0.040073	0.356350	0.112455	0.9121

R-squared	0.974092	Mean dependent var	25.06452
Adjusted R-squared	0.966689	S.D. dependent var	0.592903
S.E. of regression	0.108212	Akaike info criterion	-1.388509
Sum squared resid	0.163939	Schwarz criterion	-1.139973
Log likelihood	18.19084	Hannan-Quinn criter.	-1.346447
F-statistic	131.5912	Durbin-Watson stat	2.621454
Prob(F-statistic)	0.000000		

Source: Author's Calculation

Table A2.4 Results of investment regression (Malaysia)
Dependent Variable: LNINV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.041698	0.047586	-0.876280	0.3957
LNINV(-1)	0.703328	0.141589	4.967395	0.0002
LNODA	3.054768	7.377350	0.414074	0.6851
LNGDP	-0.179105	0.133794	-1.338667	0.2020
LNCREDIT	0.064194	0.034695	1.850248	0.0855

R-squared	0.746038	Mean dependent var	0.127197
Adjusted R-squared	0.673477	S.D. dependent var	0.038053
S.E. of regression	0.021744	Akaike info criterion	-4.598000
Sum squared resid	0.006619	Schwarz criterion	-4.349463
Log likelihood	48.68100	Hannan-Quinn criter.	-4.555937
F-statistic	10.28157	Durbin-Watson stat	2.316661
Prob(F-statistic)	0.000424		

Source: Author's Calculation

Table A2.5 Results of investment regression (Pakistan)

Dependent variable: LNINV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.116235	0.056067	-2.073135	0.0571
LNINV (-1)	0.772155	0.093476	8.260452	0.0000
LNGDPG	0.018543	0.260753	0.071114	0.9443
LNCREDIT	0.268576	0.110621	2.427895	0.0293
LNODA	0.568823	0.898698	0.632941	0.5370
R-squared	0.926354	Mean dependent var		0.114458
Adjusted R-squared	0.905312	S.D. dependent var		0.064905
S.E. of regression	0.019972	Akaike info criterion		-4.768011
Sum squared resid	0.005584	Schwarz criterion		-4.519474
Log likelihood	50.29610	Hannan-Quinn criter.		-4.725949
F-statistic	44.02436	Durbin-Watson stat		3.390097
Prob(F-statistic)	0.000000			

Source: Author's Calculation