ADBI Working Paper Series

Governance, Institutions, and Regional Infrastructure in Asia

Prabir De

No. 183
December 2009

Asian Development Bank Institute

Prabir De wrote this working paper while a visiting researcher at ADBI and is currently a fellow at Research and Information System for Developing Countries (RIS) in New Delhi, India.

The author is grateful to Mia Mikic, Robert Owen, and Biswa Bhattacharyay for their useful comments on the paper. The comments of ADBI colleagues were also useful in revising the paper. The author is also grateful to the ADBI editorial team for their excellent editing of the manuscript. The financial support and hospitality provided by ADBI is gratefully acknowledged.

Suggested citation:

De, P. 2009. Governance, Institutions, and Regional Infrastructure in Asia. ADBI Working Paper 183. Tokyo: Asian Development Bank Institute. Available: http://www.adbi.org/working-paper/2010/01/04/3425.gov.institutions.region.infrastructure.asia/

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

This study is a comprehensive, empirical analysis of the linkages between governance, institutions, and regional infrastructure. The empirical results indicate that governance and institutions are crucial for regional infrastructure development: every one point improvement in governance results in a 1 to 1.5 point rise in regional infrastructure. Countries (and regions) with higher income, stronger institutions, better governance, and more open economies are likely to have higher levels of regional infrastructure. The findings of this paper suggest that our efforts to promote regional infrastructure must not be limited to traditional policy measures aimed at attracting investment in infrastructure, but must also address policy reform across a number of areas. Thus, institutions and governance must play an important complementary role in strengthening Asia's regional infrastructure.

JEL Classification: O19, F10, F15

Contents

> While economic growth can occur in the short run with autocratic regimes,
> long run economic growth entails the development of rule of law.
> ~ Douglass C. North
> Nobel Prize Lecture, 9 December 1993

1. INTRODUCTION

In response to the ongoing global economic and financial crisis, governments around the world have pledged to spend trillions of dollars on infrastructure over the next few years. This expenditure is likely to roll out intensively between 2009 and 2015. As Gerritsen (2009: 1) noted: "This great infrastructure boom will create winners and losers. Losers will squander infrastructure spending on corruption and ineptitude. Winners will create powerful new engines of economic growth for generations to come based on new energy, globally competitive health care and strong educations."

The institutional and software components of regional infrastructure are just as important as the hardware components (Asian Development Bank [ADB] 2008; Organisation of Economic Co-operation and Development [OECD] 2009; United Nations [UN] 2009). Europe's experience suggests that improved governance and institutions along with favorable policies can facilitate the development of regional infrastructure, resulting in greater prosperity and stability for countries in the region (ADB-ADBI 2009).

Broadly defined, institutions are humanly devised constraints that structure political, economic and social interactions (North 1990). They exist to reduce uncertainties that arise from asymmetric information. Formal institutions are typically imposed by rulers, parliaments, and bureaucracies. The outcome of their actions can broadly be defined as governance, which can either be good or bad governance. In other words, governance can be defined as the process by which decisions are made and implemented. Governance is the outcome of institutions (good or bad).

This paper focuses on the role of governance in regional infrastructure development. It aims to explore whether governance is an essential prerequisite for building effective infrastructure, by:

(i) assessing the empirical relationship between governance and infrastructure;
(ii) estimating the relative strength (and intensity) of factors—including governance and institutions—that influence infrastructure development; and
(iii) assessing the impact of governance and its components on regional infrastructure development.

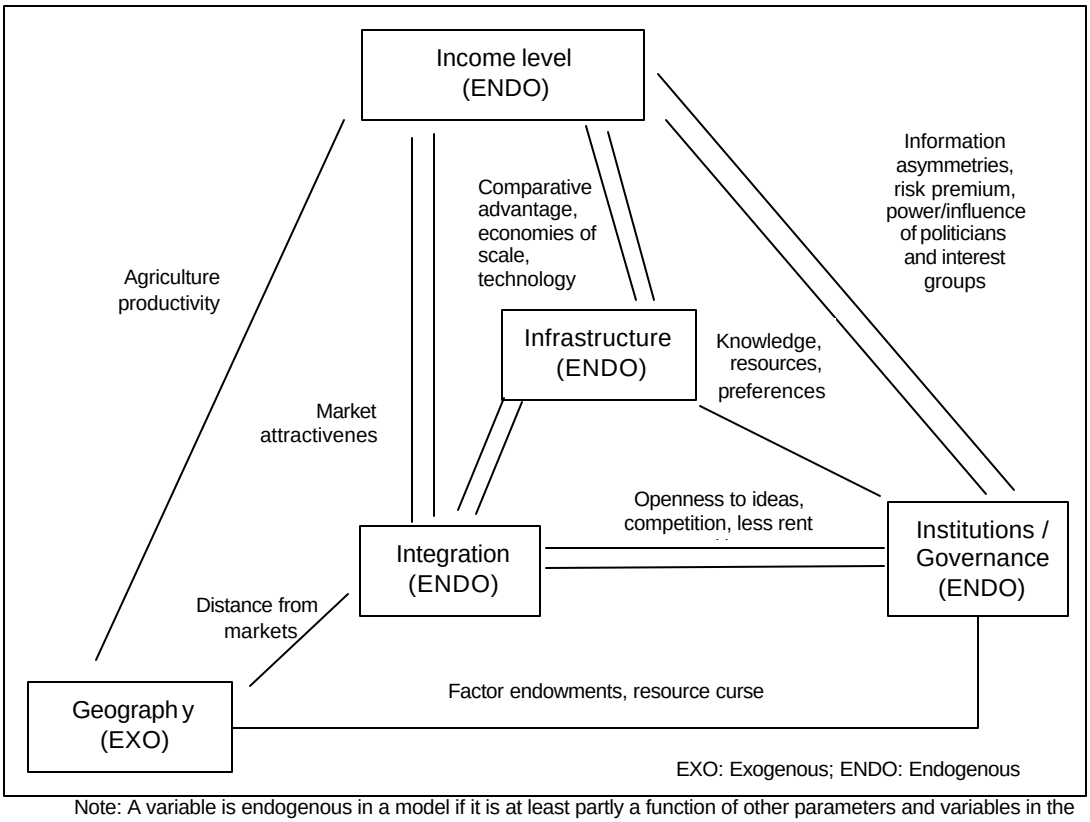
The rest of the paper is organized as follows: Section 2 presents the background of the study and explores the linkages between institutions, governance, and integration. Section 3 discusses the data and methodology, while Section 4 reviews the literature on governance and infrastructure development. Section 5 defines the governance index and its components, and presents an analysis of the performance of Asian countries in a global perspective. Section 6 discusses measurement issues and analyzes the empirical relationship between governance and infrastructure, while Section 7 presents the econometric models and estimation results. Section 8 concludes.

2. INSTITUTIONS, GOVERNANCE, AND GROWTH: EMPIRICAL LINKAGES

Various studies have demonstrated that institutional quality is crucial for economic and social development. For example, Adam Smith (1776) noted that private contracting (institutional

quality) is an important prerequisite for the mutually beneficial exchanges that promote specialization, innovation and growth—the main factors leading to gains from trade. More recent empirical studies have revealed that institutional quality is associated with (i) higher economic growth and income levels (Campos and Nugent 1998; Barro 1999; Acemoglu, Johnson, and Robinson 2002; Lee and Kim 2009); (ii) higher public and private investment (Knack and Keefer 1995; Rodrik 2003; Alfaro, Kalemli-Ozcan, and Volosovych 2005); (iii) improvements in the stock of human capital (Arimah 2004); (iv) better management of ethnic conflicts (Easterly 2001); (v) less income inequality (Chong and Gradstein 2004); (vi) better financial development (Beck et al. 2001); (vii) more efficient allocation of aid (Epstein and Gang 2009), and (viii) greater sustainability of "common resource pools" through human cooperation (Ostrom 2005), among others.

Figure 1: Determinants of Income



Note: A variable is endogenous in a model if it is at least partly a function of other parameters and variables in the model. A variable is exogenous to a model if it is not determined by other parameters and variables in the model, but is set externally and any changes to it come from external forces. An arrow indicates a causal direction.

Sources: Adapted from Rodrik, Subramanian, and Trebbi (2002) and Busse et al. (2007)

2.1 Governance, Growth, and Income: Direct Links

Figure 1 traces how institutions and governance can be an important determinant of economic growth and income levels. Governance can have a direct influence on growth and income; for example, it can help reduce transactions costs (Aron 2000; Rodrik, Subramanian, and Trebbi 2002), which are far higher if economic actors and agents cannot fully trust property rights or the rule of law. As a consequence, economic agents typically operate on a smaller scale, using inexpensive but less efficient technologies which render them less competitive. They may even retreat to the black market economy and rely on bribery and corruption to facilitate their operations (Busse et al. 2007). Ultimately, this leads to the rise of a rent-seeking, informal economy.

Overall, as explained by Rodrik, Subramanian, and Trebbi (2002), institutional quality can directly affect income levels through three channels: (i) reduced information asymmetries, as institutions channel information about market conditions, goods, and participants; (ii) reduced risk, as institutions define and enforce property rights; and (iii) greater restrictions on the actions of politicians and interest groups, as institutions make them (more) accountable to citizens (World Trade Organization [WTO] 2004). Conversely, income levels can also have an impact on institutions and governance: more developed countries are likely to have a stronger preference for high quality institutions and good governance. They would also have the requisite knowledge and resources to promote the latter.

2.2 Governance, Growth, and Income: Indirect Links

Governance can also affect growth and income indirectly, through its impact on other determining factors such as trade, investments, infrastructure, and geography.

Trade has a positive effect on income levels (Figure 1). The extent to which a country is integrated with the rest of the world is endogenous: that is, trade influences economic growth rates, and vice versa. For example, trade might not only boost growth in the medium and long run terms, it might also be the outcome of increased productivity; this, in turn, improves the country's competitiveness.

By exploiting comparative advantage and economies of scale in production, and taking advantage of technology spillovers and knowledge information, institutions and governance can boost trade and, thus, economic growth and income levels. High quality institutions also help reduce the risk premium required for international trade.

Institutional quality can be proxied by governance (Busse et al. 2007). Bolaky and Freund (2004) demonstrated that regulatory quality influences the interaction between trade and economic growth, and that countries with excessive regulations do not benefit from trade. Excessive regulations may encourage a country to produce goods for which it has no comparative advantage, or for which the terms of trade have been unfavorable over recent decades (Rodrik, Subramanian, and Trebbi, 2002).[1]

Lowering trade barriers will allow nations to benefit from exchange and specialization. However, these trade benefits would be suboptimal or unattainable in the absence of adequate infrastructure and proper institutions that practice good governance (Kohsaka 2007). Smaller economies in Asia are less likely to achieve welfare gains from trade liberalization in the presence of perennial economic asymmetries, where increased market access may produce little positive results in the short- to medium-term. The quality of institutions has been identified as a major factor for the disappointing export performance and economic underdevelopment of smaller and vulnerable economies.[2] As such, more recent free trade agreements (FTAs) tend to go beyond the standard features of an FTA by enhancing the political dimension, explicitly addressing corruption, promoting participatory approaches, and refocusing development policies on poverty reduction.[3]

Anderson and Marcouiller (2002) argued that weak institutions act as significant barriers to trade. Increasing the transparency of the trading environment through greater predictability and simplification can be an important way of reducing trade costs (Helble, Shepherd, and

[1] Trade is only beneficial if the involved adjustment costs are relatively low; that is, the reallocation of labor and capital from the import-competing sector to the export sector can be achieved at minimal costs. However, if the structure of the economy is relatively rigid, production factors cannot move to the sectors where large welfare gains can be achieved. This may result in a situation where trade does not have a beneficial impact on the allocation of resources within and between sectors.

[2] See, for example, World Bank (2001), Jutting (2003), and Levine (2005), among others.

[3] Refer, for example, to the Cotonou Agreement between the African, Caribbean and Pacific Group of States (ACP) and the European Union (EU).

Wilson 2009). De Groot et al. (2004) found that both institutional quality and existence of similar institutions in trading partners are positively associated with bilateral trade.

Trade might also influence the quality of institutions and governance through two main channels (Busse et al. 2007): (i) economic agents in open economies may learn from the experiences of their trading partners, and adapt successful institutions and regulations; and (ii) international competition may force countries to improve their institutional and regulatory setting, as a lack of reforms would otherwise force domestic producers out of business.

In addition to facilitating trade, better regional institutions improve the regional investment climate and increase FDI inflows into each member country (Busse et al. 2007). Rent seeking and corruption might be harder in more open economies, as foreign firms increase the number of economic agents involved (Rajan and Zingales 2003).

One highly relevant variable that directly affects income, trade, institutions, and governance is geography. Not many indicators are as exogenous as a country's geographical location (Rodrik, Subramanian, and Trebbi 2004). Geography can have a direct impact on income through climate, natural resource endowments, and agricultural productivity. At the same time, an abundance of resources can have an impact on institutional quality in developing countries, since this enriches (and may even corrupt) the ruling class (Bulte and Damania 2005).

Geography can also have an indirect impact on income through its influence on trade, where the distance from major markets and the degree of integration play a vital role. Strong institutional coordination, coupled with improved infrastructure, helps minimize international trade costs (Francois and Manchin 2007).

Quite clearly, good governance and growth are positively correlated, and the quality of institutions and policies affect long-run economic growth. It is the interaction between institutions and organizations that shapes the institutional evolution of an economy (or a region).

3. DATA AND METHODOLOGY

3.1 Measuring Governance

In this paper, I use a comprehensive set of disaggregated indicators to measure governance. I identify those components of governance and institutions that matter most for the successful development of regional infrastructure. I construct a composite governance index (GI) based on the six governance indicators taken from the Worldwide Governance Indicators (WGI) database[4] of the World Bank Institute (WBI). Following the definition provided in the WGI (Kaufmann, Kraay, and Mastruzzi 2008: 7):

> Governance consists of the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them.

[4] This database has been compiled by Daniel Kaufmann and Massimo Mastruzzi of the World Bank Institute and Aart Kraay of the Development Research Group, the World Bank.

The GI is averaged using the following governance indicators: (i) voice and accountability; (ii) political stability and absence of violence/terrorism; (iii) government effectiveness; (iv) regulatory quality; (v) rule of law; and (vi) control of corruption. The GI represents the economic and political governance environment in 174 countries for the period 1996 to 2007. Appendix 1 provides a definition of the GI components, and explains the WBI's methodology for deriving them.

3.2 Measuring Regional Infrastructure

Following the definition adopted in ADB/ADBI's "Infrastructure for a Seamless Asia" study (ADB/ADBI, 2009), regional infrastructure in this paper is defined as: (i) infrastructure facilities that involve physical infrastructure, and/or coordinated policies and procedures spanning two or more neighboring countries; (ii) national infrastructure projects that have a significant cross-border impact, in that their planning and implementation involve cooperation or coordination with one or more neighboring governments; and (iii) infrastructure facilities that aim to stimulate significant amounts of regional trade, or are designed to connect to the network of a neighboring or third country.

In this paper, regional infrastructure is represented by the Physical Infrastructure Index (PII), a composite index based on six physical infrastructure indicators representing regional and international infrastructure stocks of (i) roadways; (ii) railways; (iii) telecommunications; (iv) ports; (v) airports; and (vi) electricity. The PII covers the period 1991 to 2006, for 124 countries where regional, national, and subnational authorities have a direct role either in the provision or regulation of these infrastructure facilities.[5] These indicators individually and/or jointly represent a region's physical infrastructure stock.

Infrastructure quality and stock represent the relative income-generating capacity of each individual country. By including the infrastructure facilities enumerated in (i) to (v) in the PII, regional infrastructure components are also relatively well captured. The PII was obtained using Principal Component Analysis (PCA).[6] Appendix 2 presents the weights derived from PCA and the indexing methodology. To check the relative robustness of PII, I also used the infrastructure index of the World Economic Forum (WEF), constructed using a perception survey (qualitative data) on 131 countries for the period 2001 to 2008 (WEF 2009).

Finally, I measured the empirical relationship between governance and infrastructure using both cross-section and pooled data. Allowing for the complex relationship between regional infrastructure and governance in institutions, I used both the Generalized Method of Moments (GMM) and Instrumental Variable (IV) regressions to account for endogeneity of the variables. The model and its specifications are discussed in Section 7.

Governance indicators were derived from the Worldwide Governance Indicators (WGI) database, published by the World Bank Institute (WBI 2008). For the infrastructure indicators, I used multiple sources such as various issues of the World Competitiveness Report (WCR), published by the World Economic Forum (WEF), and various issues of World Development Indicators (WDI), published by the World Bank (World Bank 2008). The infrastructure indicators have been supplemented by the author's own cross-country infrastructure database.[7]

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[5] All the infrastructure facilities across countries have been normalized in terms of either population or geographical area for each different time point. This makes them amenable to comparison, irrespective of state size and population.

[6] The infrastructure indicators have been rendered unit- and scale-free before running PCA.

[7] This has been drawn from the author's own Asia Infrastructure Database (AID), a part of which has been used in Kumar and De (2008) and the Economic Research Institute of ASEAN and East Asia (ERIA 2007).

4. GOVERNANCE IN INFRASTRUCTURE: LITERATURE REVIEW

"Governance" has risen from obscurity to buzzword in just three decades (Dixit 2009).[8] Governance has several dimensions, such as economic governance, corporate governance, international governance, regional governance, national governance and local governance (Dixit 2009). An appropriate institutional and policy framework is needed for effective governance (WBI 2008; UNESCAP 2006; ADB 2008).

As noted by Dixit (2009), good economic governance is needed to secure three essential prerequisites: (i) collective action; (ii) enforcement of contracts; and (iii) security of property rights. It assures that corruption is minimized, that the views of minorities are taken into account, and that the voices of the most vulnerable in society are heard in decision-making. Good economic governance is also responsive to the present and future needs of society (UN 2009).

Good governance is one of the three pillars of ADB poverty reduction strategy. Assisting developing countries in improving governance is a strategic priority of ADB in its work to eliminate poverty in Asia and the Pacific (ADB 2009).[9] ADB recognizes a diversity of political systems and institutional cultures in the region. Nonetheless, it defines four aspects of sound governance which are relevant for all countries[10]:

(i) Accountability: Officials are answerable to the entity from which they derive their authority; work is conducted according to agreed rules and standards, and reported fairly and accurately.
(ii) Participation: Public employees are given a role in decision making; citizens, and especially the poor, are empowered by promoting their rights to access and secure control over basic entitlements that allow them to earn a living.
(iii) Predictability: Laws, regulations, and policies are applied with fairness and consistency.
(iv) Transparency: Low cost, understandable, and relevant information are made available to citizens to promote effective accountability, and clarity about laws, regulations, and policies.

In general, good governance has eight major characteristics: it is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive, and mindful of the rule of law.

A region's infrastructure network, broadly speaking, is the very socio-economic climate created by the institutions that serve as conduits of trade and investment. Some of these institutions are public, others private. In either case, their roles in the context of integration are transformative, helping to change resources into outputs or to enhance trade by removing barriers. Therefore, an improvement in regional infrastructure is one of the key factors affecting the long-term growth of a region.

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[8] According to EconLit, "world governance" was mentioned 5 times in the 1970s; by the end of 2008, reference to "governance" had increased to 33,177, with 'economic governance' appearing 192 times, and 'corporate governance' appearing 9,717 times (Dixit 2009).

[9] ADB, for example, has been implementing the Governance and Anticorruption Action Plan (GACAP), funded by the Governance Cooperation Fund (GCF), for the improvement of governance in selected member countries (ADB 2009).

[10] ADB's approach to governance, established as a Core Strategic Area of Intervention under its Long-term Strategic Framework (2001–2015), recognizes the importance of capacity development and identifies these four key interrelated elements that are considered necessary to sustain efforts and ensure results. Refer, for example, to ADB (1995, 2006a, 2009), and Wescott (2005).

The linkages between infrastructure and economic growth are multiple and complex. Not only does infrastructure affect production and consumption directly, it also creates many direct and indirect externalities. It also involves large flows of expenditure, thereby creating additional employment. Studies have shown that infrastructure can have a significant impact on output, income, employment, international trade, and quality of life.[11]

Infrastructure has always played a key role in integrating economies within a region. Well-developed and efficient infrastructure is essential for a region's economic development and growth. In a dynamic concept, infrastructure is seen as a regional public good that moves factors of production within and across countries, thus helping the region attain higher productivity and growth (Figure 1).

In a regional setting, infrastructure is a combination of two components: national and international (regional) infrastructure. Regional infrastructure is seen as one of the major determinants of the economic integration process (Vickerman 2002; Kuroda, Kawai, and Nangia 2007; Venables 2007; Francois, Manching and Balaoing 2009). Regional infrastructure is non-rival in consumption, functions as a regional public good, and enhances regional connectivity. It is often argued that if countries in a region are not linked through efficient infrastructure facilities, then the regional integration process would undoubtedly slow down.[12]

Investments toward improving sector policies, governance, and the institutional environment need to be better targeted. As Kuroda, Kawai, and Nangia (2007: 253) have commented: "The strong need for planning and coordination for cross-border infrastructure requires a systematic institutional arrangement, whether formal or informal. Though in theory, *ad hoc* institutional and technocratic coordination and negotiations between governments on a project-to-project basis should work well without a formalized institutional or legal framework, in reality this approach has had high failure rates and long lead times, significantly raising transaction costs and making such collaborations infeasible. Strong institutional coordination helps minimize such costs. A systematic, comprehensive, institutionalized approach is essential for success."

Improved governance and policies have promoted prosperity and stability in participating countries. A study by the ADB-WB-JBIC (2005), for instance, found that the lack of infrastructure sector reform and minimal privatization of existing assets gave little room for competition or independent regulation. According to ADB (2006b), the varying strengths and weaknesses of regulatory regimes between countries make regional infrastructure projects difficult to coordinate and develop, particularly with regard to securing private sector financing, which requires strong regulation to mitigate risks.

In many cases, poor governance operates no differently from a tax: it deters economic activity just as a tax would (Dixit 2009). In order for the benefits of long-term infrastructure investments to trickle down in Asia, the governance of infrastructure is crucial. The ADB, in its Regional Cooperation and Integration Strategy on cross-border infrastructure, tackled a range of issues including public and private roles in provision, regulation, and management.[13] It highlighted the vital importance of governance, while suggesting several approaches to promoting regional integration.

There have been considerable changes in the delivery of national and international infrastructure services worldwide. However, performance in terms of infrastructure service delivery and quality continue to vary across sectors, regions, and countries. Jones (2006),

[11] Refer, for example, to Munnell (1990); Fedderke, Perkins, and Luiz (2006); Aschauer (1989); World Bank (1994); Ghosh and De (2005); Kohsaka (2007); and Batten and Karlsson (1996).

[12] A vast literature exists on the impact of infrastructure on regional integration. Refer, for example, to Brooks and Menon (2008).

[13] See, for example, ADB (2006c)

for example, has noted that in some Asian countries, infrastructure investment has not had the anticipated long-term impact on the quality and extent of utility and transport services. Privatization and competition have had some success in some countries (World Bank 2005); across sectors, there is also evidence to suggest that private provision can improve the quality of services and the extent of provision (Levy 2007). At the same time, however, it appears that many of the institutional weaknesses underlying poor provision and low sustainability are not solved by allowing private investment, and in some sectors private provision is likely to have a comparatively minor role (Kenny 2007).

Successful regional infrastructure development requires appropriate institutional arrangements. Institutional and software components in regional infrastructure are just as important as the hardware components (Kuroda, Kawai, and Nangia 2007). For any hard infrastructure facility to work, well-designed institutional and software support is essential. Jansen and Nordas (2006) argued that trade policies at home and abroad matter most for home imports, together with foreign institutions and home infrastructure.

The importance of institutions to infrastructure performance is also evident from an analysis of the costs of corruption in the infrastructure sector.[14] While corruption is a symptom of failed governance, it can also further weaken the governance environment. Corruption not only raises the price of infrastructure, it can also reduce the quality of, and economic returns to, infrastructure investment. Corruption can lower the quality of public infrastructure (Bose, Capasso, and Murshid 2008); some studies (Tanzi and Davodi 1998; Gulati and Rao 2006; Kenny 2009) also indicate that corruption (petty and grand) in infrastructure development negatively impacts a country's growth. Thus, transparency has been viewed as a key factor in reducing corruption (Kolstad and Wiig 2009).

In Asia, the public sector is involved in regulating and supplying the bulk of national and regional infrastructure. Therefore, there is a strong need for regional public policy. Good governance at the regional level has a direct and positive effect on the local governance of each country in the region (Shepotylo 2006). I call this governance diffusion.

Without adequate regulation and institutions, regional infrastructure provision will be suboptimal (OECD 2009). Therefore, good institutional governance is essential for achieving a seamless Asia.

Since governance is multidimensional, an analysis of governance will have to include more factors than income. The question of how governance should be measured has recently received growing attention. While studies have focused on the links between national infrastructure and governance and institutions, thus far, no empirical study has focused on the links between governance and regional infrastructure. Do improved governance and institutions promote regional infrastructure? The rest of this paper is devoted to answering this question.

5. MEASURING GOVERNANCE IN INSTITUTIONS: CROSS-COUNTRY COMPARISONS

There are two dimensions to measuring any governance system (Kaufmann, Kraay, and Mastruzzi 2007): regulatory governance and regulatory substance.

[14] Refer, for example, to the seminal works of Kaufmann, Kraay, and Mastruzzi (2006), and Rose-Ackerman (1975) on the economics of corruption.

- Regulatory governance is measured using rules-based or de jure indicators. These indicators look at whether the requisite legislations or regulatory entities for facilitating investments in infrastructure are in place (the how of governance/rules in the book).
- Regulatory substance is measured using outcome-based or de facto indicators. These indicators look at whether de jure rules are enforced in practice as intended by law (the what of governance/rules on the ground).

As noted by Kaufmann, Kraay, and Mastruzzi (2008), a rules-based indicator of corruption might measure the extent to which countries have legislation prohibiting corruption, or simply reflect whether an anticorruption agency exists. An outcome-based measure, on the other hand, could assess whether the laws are enforced, or whether the anticorruption agency is undermined by political influence.

Following Kaufmann, Kraay, and Mastruzzi (2007), I considered both *de jure* and *de facto* indicators of governance. The governance index (GI) for each country was constructed by taking the mean of six governance indicators: (i) voice and accountability; (ii) political stability and absence of violence/terrorism; (iii) government effectiveness; (iv) regulatory quality; (v) rule of law; and (vi) control of corruption.[15]

Although good governance measures are perception-based indicators, I have used them in this study since they are the only comparable figures available for a very large number of countries, including most of the Asian countries. No other source of information on governance and institutional quality covers the Asian region in such a comprehensive manner.

I calculated the GI for 174 countries for the period 1996 to 2007. Tables 1a and 1b present a global ranking of the ten best and worst performing countries based on the GI. Table 2 presents the same for the East Asia Summit (EAS) countries[16]. A correlation matrix for good governance indicators is presented in Table 3.

[15] Specifically, $GI_i^t = \frac{1}{n}\left(\sum_{j=1}^{n} X_{ij}^t\right)$, where X^t_{ij} represents governance indicators of country *i* for the year *t*. All indicators are standardized with a mean of 0 and a standard deviation of 1, and range from -2.5 to +2.5.

[16] EAS represents ASEAN+6: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam, Australia, India, Japan, New Zealand, People's Republic of China, and Republic of Korea.

Table 1a: Global Ranks of Top 10 Countries in GI

Country	2007	1996
Switzerland	1	4
Iceland	2	21
Finland	3	8
Luxembourg	4	11
Sweden	5	7
New Zealand	6	3
Denmark	7	10
Norway	8	5
Austria	9	9
Ireland	10	17

Note: Spearman rank correlation (174) (2007&1996) = 0.923

Table 1b: Global Ranks of Bottom 10 Countries in GI

Country	2007	1996
Cote D'Ivoire	165	92
Chad	166	147
Guinea	167	135
Sudan	168	168
Zimbabwe	169	122
Afghanistan	170	167
Congo, D.R	171	169
Myanmar	172	163
Iraq	173	172
Somalia	174	174

Note: Spearman rank correlation (174) (2007&1996) = 0.904

Table 2: Global Rank of EAS Countries in GI

Country	2007	1996
Australia	13	13
Brunei Darussalam	54	41
Cambodia	141 (?)	149
China, People's Rep.	109	97
Hong Kong, China	20 (?)	32
India	81 (?)	94
Indonesia	118	112
Japan	24 (?)	26
Korea, Republic of	41 (?)	49
Lao PDR	148	126
Malaysia	61	47
Myanmar	172	163
New Zealand	6	3
Philippines	110	69
Singapore	22	20
Thailand	90	57
Viet Nam	114 (?)	118

Note: Spearman rank correlation (17) (2007&1996) = 0.957. Upward arrow means improvement in ranks in 2007, compared to 1996.

Table 3: Correlation Matrix for Good Governance Indicators, 2007

Item	GDP Per Capita[#]	Control of Corruption	Rule of Law	Regulatory Quality	Government Effectiveness	Political Stability	Voice and Accountability
GDP Per Capita[#]	1						
Control of Corruption	0.875*	1					
Rule of Law	0.838*	0.954*	1				
Regulatory Quality	0.803*	0.884*	0.898*	1			
Government Effectiveness	0.893*	0.939*	0.941*	0.948*	1		
Political Stability	0.682*	0.732*	0.792*	0.680*	0.715*	1	
Voice and Accountability	0.661*	0.769*	0.777*	0.819*	0.792*	0.646*	1

Note: *Significant at 5% level. #Taken in log scale. **Sample (country) = 174

A number of results are worth highlighting. First, with the exception of New Zealand, the best performers in the GI in 2007 were from Europe; in contrast, most of the bottom 10 countries were from Africa. At the same time, the correlations suggest that there has been very little change in the ranking of countries in the top and bottom 10 positions. This suggests a high degree of stickiness in the relative rankings of the countries in terms of the GI.

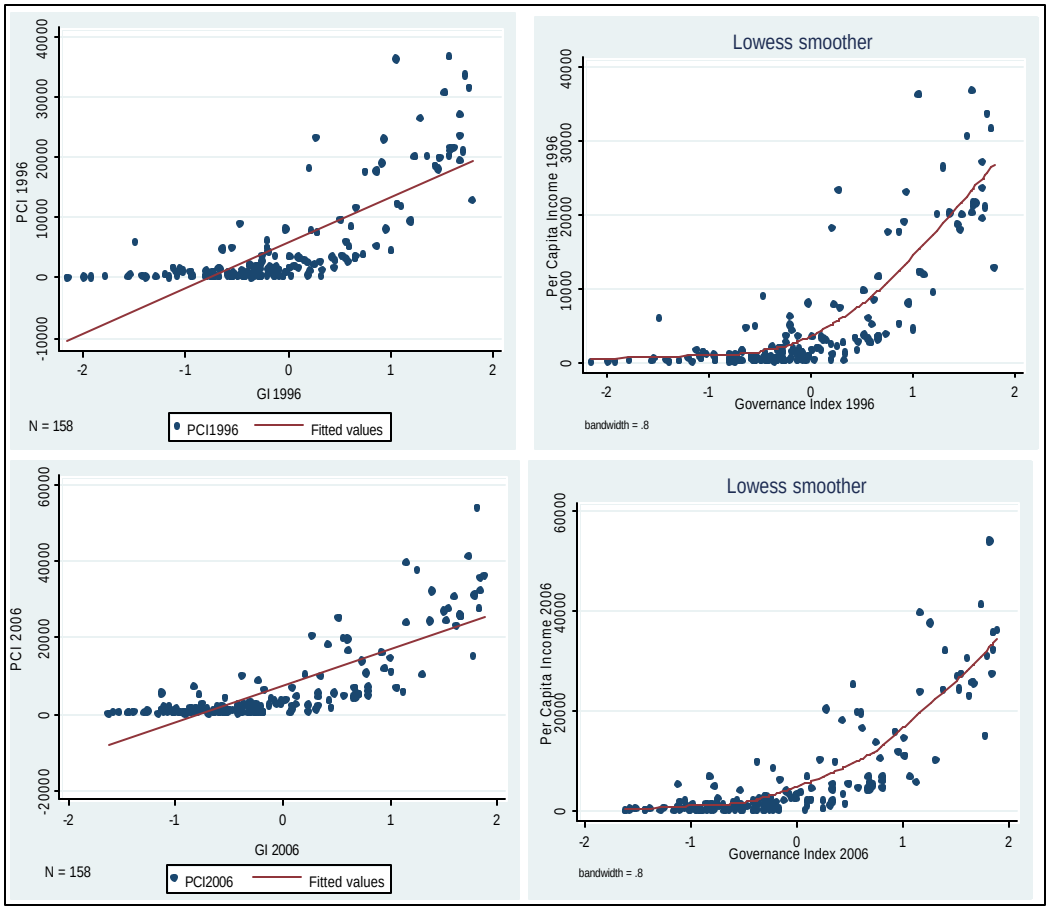
Second, smaller countries seem to have made bigger strides in improving governance than bigger countries; Iceland's performance has been most impressive, with its global rank improving from 21 in 1996 to 2 in 2007.[17] In contrast, Somalia has consistently ranked last in the global league table.[18]

Third, the performance of EAS countries in the GI has been mixed. While some countries such as Japan, Republic of Korea, India, Hong Kong, China, Viet Nam and Cambodia have improved their global ranking, many EAS countries have actually experienced a deterioration in their rankings between 1996 and 2007. Wide variations likewise exist: while New Zealand garnered a spot in the top 10, Myanmar appeared in the bottom 10 countries in 2007. In relative terms, governance in Asian countries such as the Philippines, Cambodia, Lao PDR, the People's Republic of China (PRC), Viet Nam, and Indonesia has remained unsatisfactory.

[17] Although Iceland was badly ravaged by the ongoing global economic crisis, it still managed to rank second in best governance.

[18] For some time, Somalia was in the limelight due to incidences of sea piracy.

Figure 2: Scatter Plot of Per Capita Income vs. Governance



Note: PCI represents per capita income in constant US$.

Data source: World Bank (2008).

Fourth, given that the GI components are perception-based indicators, it is not surprising that all six indicators are closely associated with the log of GDP per capita. The partial correlations fall within the range of 0.66 to 0.89, indicating a very close linkage with per capita income (Table 3). Most of the indicators are likewise closely related to one another, with partial correlations consistently at or above 0.65. Per capita income and aggregate governance are also highly correlated (Figure 2). The scatter diagrams drawn separately for 1996 and 2007 in Figure 2 do not only indicate a positive association between governance and per capita income, but also reveal a relative change in levels between 1996 and 2007.[19]

Quite clearly, the ordinal measures adopted in this paper evince the lack of significant change in the relative rankings of countries in terms of governance between 1996 and 2007. Meanwhile, the correlations suggest that countries with better governance also tend to have higher per capita income.[20]

[19] I used Lowess plots to explore the relationship between per capita income and governance. These locally-weighted regressions use a function that attaches less weight to points far from the mean. Figures 2 in this paper show the Lowess plot for the default options in Stata 10, which include a bandwidth of 0.8 (this means that in each regression, 80% of the observations are included) and a Tricube Weighting scheme (this means that the observations farther away from the mean get a lower weight). Results are robust to changes in the weighing scheme, including a change to a rectangular weighting scheme (in which all observations get equal weights) and a change in the band width. This pattern is also robust to changes in year.

[20] This association does not talk about the direction of causality between income per capita and governance.

Do countries with higher per capita income and better governance also have higher levels of regional infrastructure? To answer this question, I look at the relationship between infrastructure and governance, using the same set of countries.

6. REGIONAL INFRASTRUCTURE AND GOVERNANCE: ASIA IN THE WORLD

Investing in infrastructure facilities such as roads, railways, seaports, airports, electricity, and telecommunication requires a long period of time and an enormous amount of intra-generational resource transfers. The presence of such infrastructure facilities has a direct impact on production, and benefit a region by "crowding in" private investment (both domestic and foreign).The absence of such facilities in a region may result in lower "productive efficiency"; previous studies have shown that a decline in region's productivity is often preceded by a fall in infrastructure investment.[21]

In this study, I have constructed the physical infrastructure index (PII), a composite index comprised of six physical infrastructure indicators: (i) roadways; (ii) railways; (iii) airports; (iv) seaports; (v) telecommunications; and (vi) electricity. The index was calculated for 124 countries for the period 1995 to 2006. Appendix 3 provides a definition of these variables and their corresponding sources. Using Principal Component Analysis (PCA), the PII is constructed as a linear combination of the unit- and scale-free values of the individual facilities.[22]

Table 4 presents a global ranking of the best and worst performing countries in terms of the PII for the year 2006. To check the relative robustness of the PII, Table 5 presents a similar ranking of countries using the World Economic Forum's (WEF) infrastructure index.

A number of results are worth noting. First, developed countries occupy the top 10 positions in the PII ranking, whereas the bottom 10 positions are occupied by least developed countries in Africa, with the exception of Cambodia. Except for a few cases, these results are largely consistent with the WEF rankings presented in Table 5.

Second, while some of the Asian countries saw improvements in their global rankings between 1996 and 2006 (Table 6), on the whole, the stock of infrastructure in East Asian countries remains remarkable low, with the exception of Japan and Singapore. The disparities in regional infrastructure stock, both among East Asian countries as well as in relation to developed economies, are not only alarmingly high but also growing. While the PRC has made huge strides in improving its infrastructure, the poor performance of countries like Indonesia remains a matter of serious concern.

Third, there is clearly prima facie evidence of a positive association between infrastructure and per capita income (Figure 3). This implies that although the ranking of countries has not changed much between 1996 and 2006 (given the high correlation of 0.972), countries with a higher stock of infrastructure have also enjoyed higher income over time.

[21] Refer, for example, to Munnell (1990).

[22] Specifically, $PII_{ij} = \sum W_{kj} X_{kij}$, where PIIij is infrastructure index of the i-th country in j-th time, Wkj is weight of the k-th facility in j-th time, and Xkij is the unit- and scale- free value of the k-th facility for the i-th country in j-th time point. This helps us to derive the index (score) after adding the multiplied values corresponding to each category. As discussed, the weights (Wkj) in this equation were derived using PCA.

Table 4a: Global Ranking of Countries in Regional Infrastructure based on the PII: Top 10 Countries

Country	2006
Germany	1
Japan	2
Singapore	3
Switzerland	4
Netherlands	5
Denmark	6
Sweden	7
United States	8
Ireland	9
Norway	10

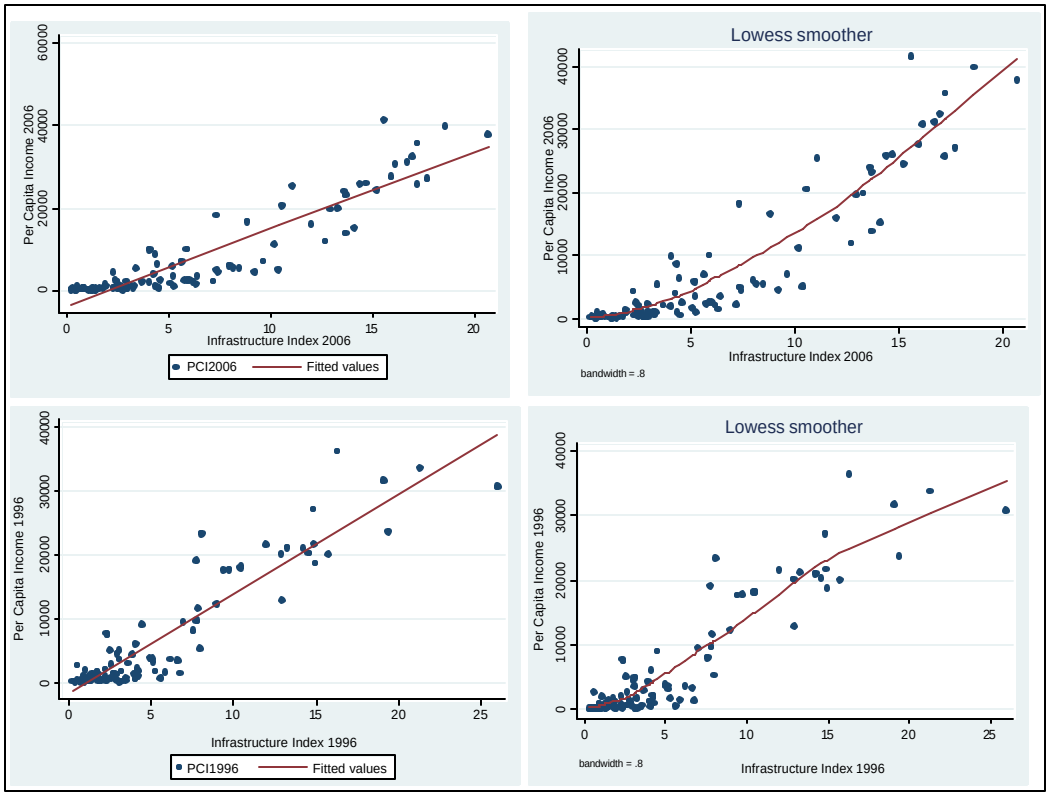
Source: Author's own calculation.

Table 4b: Global Ranking of Countries in Regional Infrastructure based on the PII: Bottom 10 Countries

Country	2006
Cambodia	116
Mozambique	117
Tanzania	118
Uganda	119
Angola	120
Somalia	122
Congo, Rep. of	123
Central African Republic	124
Congo, Dem. Rep. of	125
Chad	126

Source: Author's own calculation.

Figure 3: Scatter Plot of Per Capita Income vs. Infrastructure (PII)



Source: Author's own calculation.

Table 5a: WEF Global Ranking of Countries in Regional Infrastructure; Top 10 Countries

Country	2007
Germany	1
France	2
Singapore	3
Switzerland	4
Hong Kong, China	5
United States	6
Denmark	7
Canada	8
Japan	9
Finland	10

Source: World Economic Forum (http://www.weforum.org/en/index.htm).

Table 5b: WEF Global Ranking of Countries in Regional Infrastructure; Bottom 10 Countries

Country	2007
Mauritania	122
Cameroon	123
Albania	124
Mongolia	125
Paraguay	126
Lesotho	127
Nepal	128
Burundi	129
Timor-Leste	130
Chad	131

Source: World Economic Forum (http://www.weforum.org/en/index.htm).

Table 6: Ranking of EAS Countries in Infrastructure based on the PII

Country	2006	1996
Australia	14	8
Brunei	33	22
Cambodia	116	103
China, People's Rep.	36 (?)	49
India	53 (?)	58
Indonesia	69	66
Japan	2 (?)	5
Korea, Republic of	18 (?)	26
Lao PDR	92 (?)	97
Malaysia	29 (?)	37
Myanmar	111	93
New Zealand	15	13
Philippines	74 (?)	76
Singapore	3 (?)	6
Thailand	48	43
Viet Nam	71 (?)	79

Note: Spearman rank correlation (16) (2006&1996) = 0.972. Upward arrow means improvement in ranks in 2006, compared to 1996.

Source: Author's own calculation.

Table 7: Correlation Matrix for Infrastructure, Governance, and Income (2006)

Item	GI	RL	RQ	GE	PS	VA	CC	PCI#	PII
GI	1								
RL	0.968*	1							
RQ	0.941*	0.891*	1						
GE	0.962*	0.940*	0.948*	1					
PS	0.819*	0.772*	0.671*	0.699*	1				
VA	0.858*	0.766*	0.792*	0.764*	0.649*	1			
CC	0.954*	0.952*	0.880*	0.937*	0.716*	0.758*	1		
PCI#	0.803*	0.806*	0.767*	0.821*	0.563*	0.601*	0.845*	1	
PII	0.878*	0.894*	0.856*	0.903*	0.633*	0.703*	0.885*	0.920*	1

Note: GI = Governance Index; RL = Rule of Law; RQ = Regulatory Quality; GE = Government Effectiveness; PS = Political Stability; VA = Voice and Accountability; CC = Control of Corruption; PCI = Per Capita Income; PII = Physical Infrastructure Index. *Significant at 5% level. **Sample (country) = 158. #Taken in log scale

Source: Author's own calculation.

Having seen the relative positions of the countries in the infrastructure-income plane, I now test the nature of the relationship between regional infrastructure and governance. Does improved governance help countries attain higher levels of infrastructure? The scatter diagrams in Figures 4 to 10 reveal the following correlations.

First, infrastructure is highly correlated with governance (Table 7). Most of the governance indicators have partial correlation coefficients in the high range of 0.6 to 0.9, indicating that (i) the linkage between infrastructure and governance is based on a broader range of indicators; and (ii) this linkage does not vary considerably among the indicators.

Second, when represented by aggregate indices, governance and infrastructure continue to show a positive correlation, suggesting that good governance underpins infrastructure development (Figure 3). In general, rule of law, regulatory quality, government effectiveness, voice and accountability, control of corruption, and political stability do facilitate the development of both regional and national infrastructure.

Third, infrastructure also shows a positive association with most of the GI indicators: rule of law (Figure 5), regulatory quality (Figure 6), government effectiveness (Figure 7), political stability (Figure 8), and voice and accountability (Figure 9). These can therefore be viewed as the basic ingredients of governance that a country should possess. Simply put, countries which lack good governance are likely to fail in improving infrastructure, regional or otherwise.

Fourth, contrary to popular belief, corruption (as represented by unofficial payments) does not have a positive association with infrastructure (Figure 10).[23] Both petty and grand forms of corruption do not facilitate the development of infrastructure. However, the congestion at origin in both Figures 10a and 10b indicates that one cannot immediately discount the "thin" positive association between corruption and infrastructure development, perhaps at the initial stages of development, *ceteris paribus*.

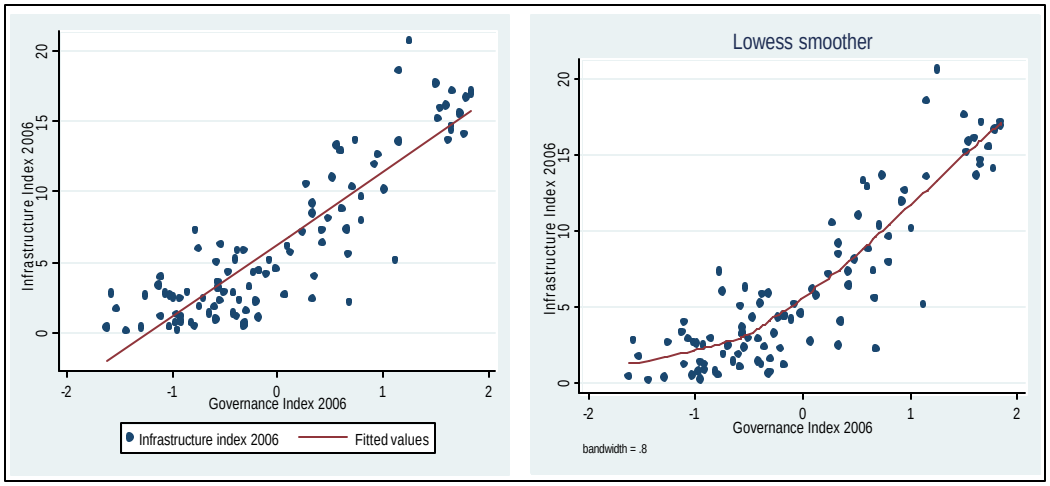
Fifth, poor governance clearly raises uncertainty, leading private investors (both domestic and foreign) to increase the risk premium for investments in infrastructure; this, in turn, reduces overall investment and diminishes the prospects for economic development.

To sum up, the linkages between regional infrastructure and governance are multiple and complex. Governance reforms are therefore one of the important factors affecting

[23] Unofficial payments to public officials are the percentage of firms expected to make informal payments to public officials to "get things done" with regard to customs, taxes, licenses, regulations, services, and the like. Data is available from the World Bank, Enterprise Surveys (http://www.enterprisesurveys.org). Replacing the PII with the infrastructure index of WEF does not change the result, and instead makes the association more robust.

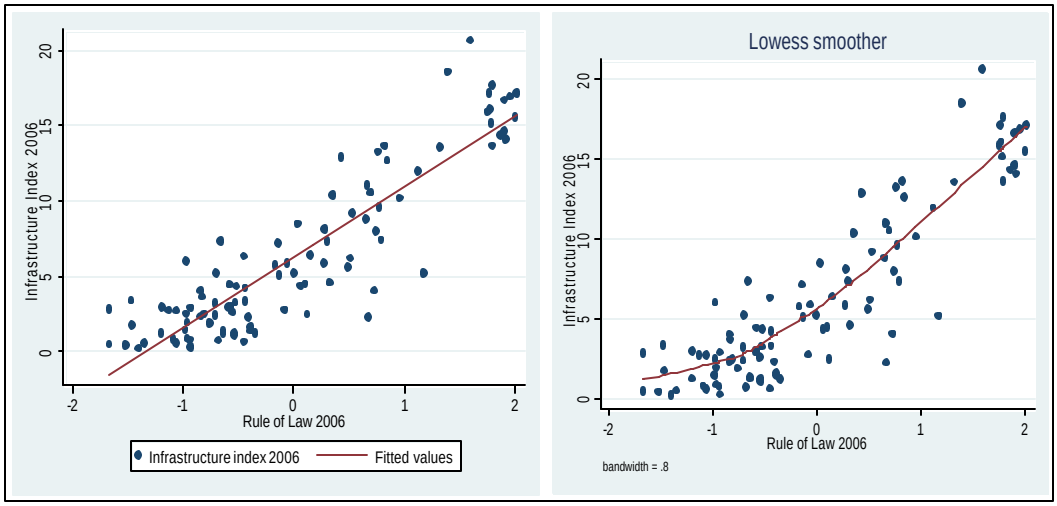
infrastructure development. Without adequate governance, the provision of regional infrastructure will be suboptimal and unsustainable. But can governance alone determine regional infrastructure development? I attempt to answer this question next.

Figure 4: Scatter Plot of Infrastructure vs. Governance



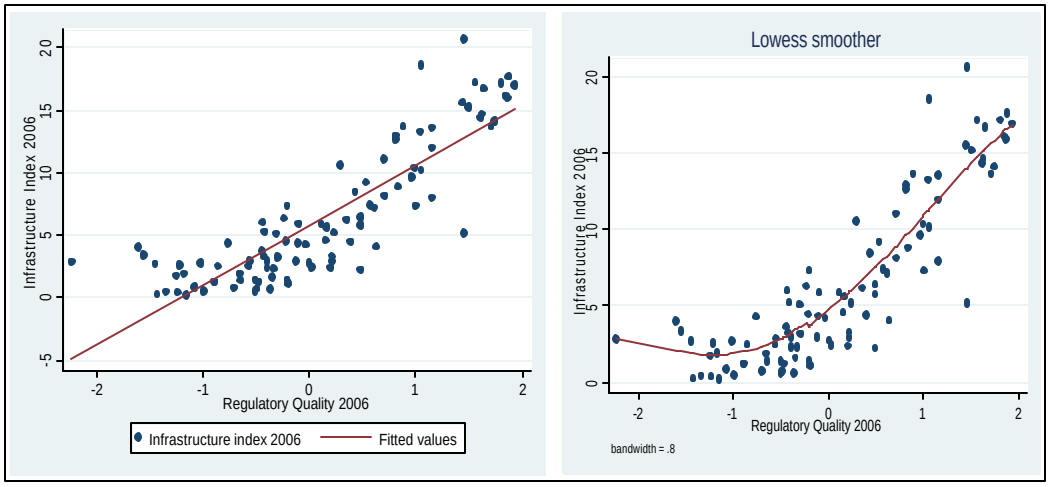
Source: Author's own calculation.

Figure 5: Scatter Plot of Infrastructure vs. Rule of Law



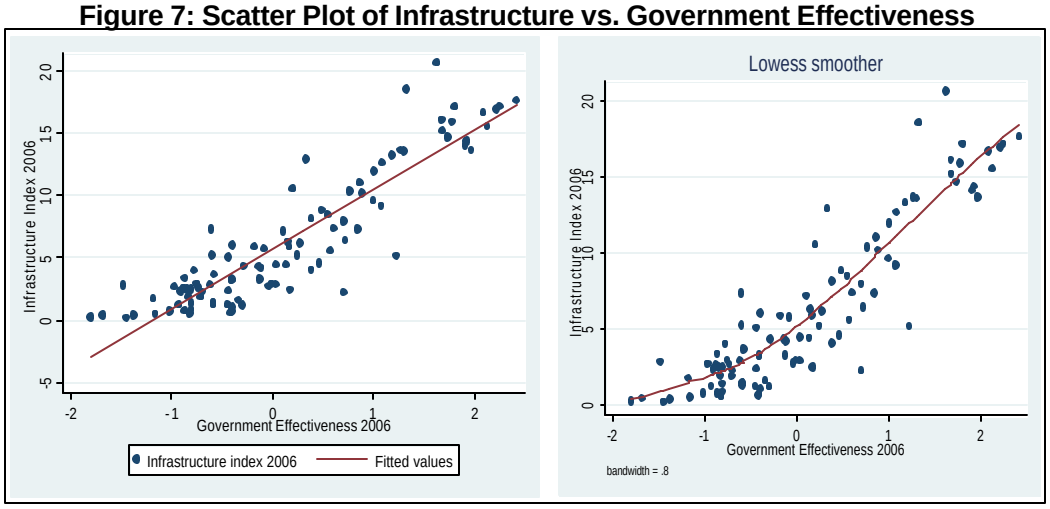
Source: Author's own calculation.

Figure 6: Scatter Plot of Infrastructure vs. Regulatory Quality



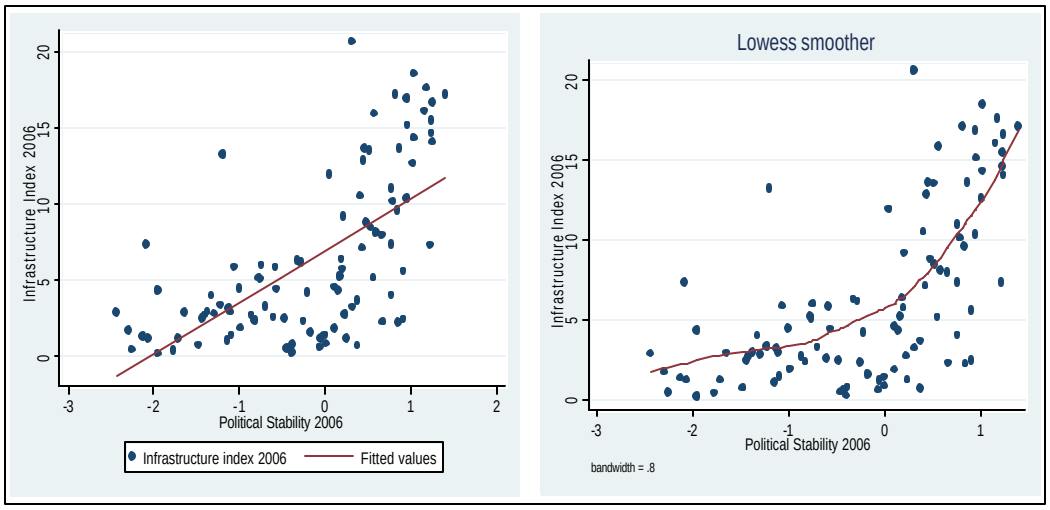
Source: Author's own calculation.

Figure 7: Scatter Plot of Infrastructure vs. Government Effectiveness



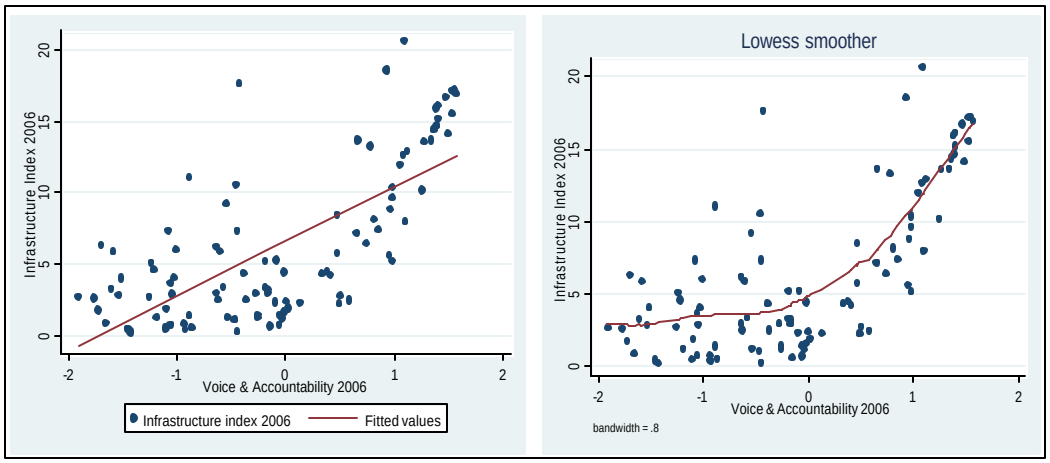
Source: Author's own calculation.

Figure 8: Scatter Plot of Infrastructure vs. Political Stability



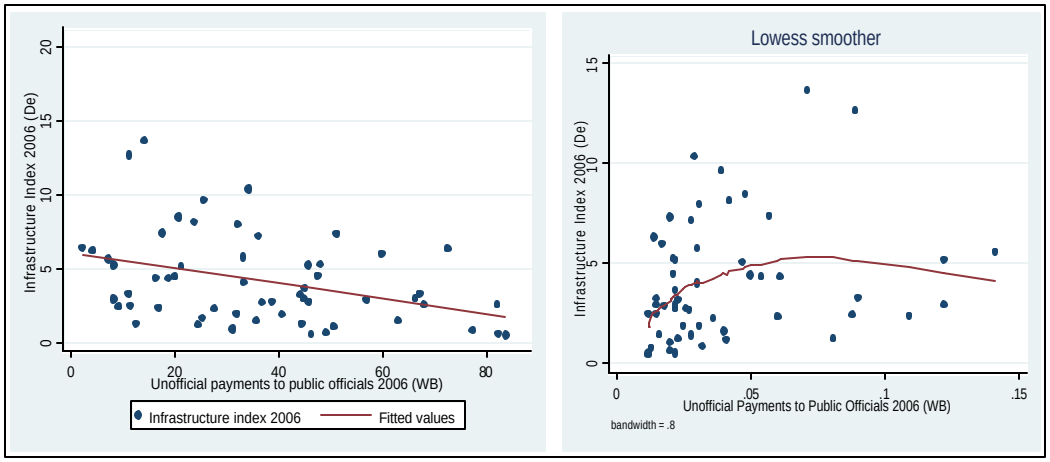
Source: Author's own calculation.

Figure 9: Scatter Plot of Infrastructure vs. Voice and Accountability



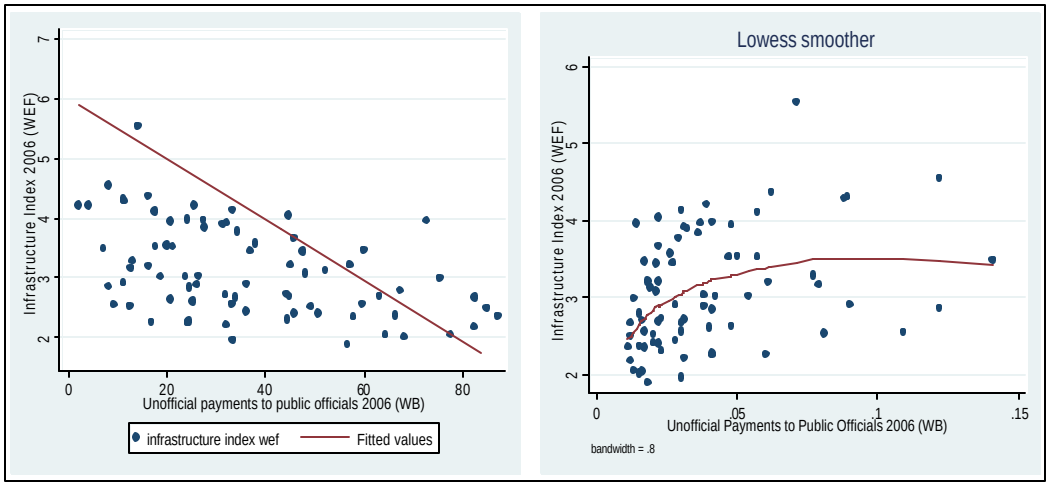
Source: Author's own calculation.

Figure 10a: Scatter Plot of Infrastructure (PII) and Unofficial Payments



Source: Author's own calculation.

Figure 10b : Scatter Plot of Infrastructure (WEF) and Unofficial Payments



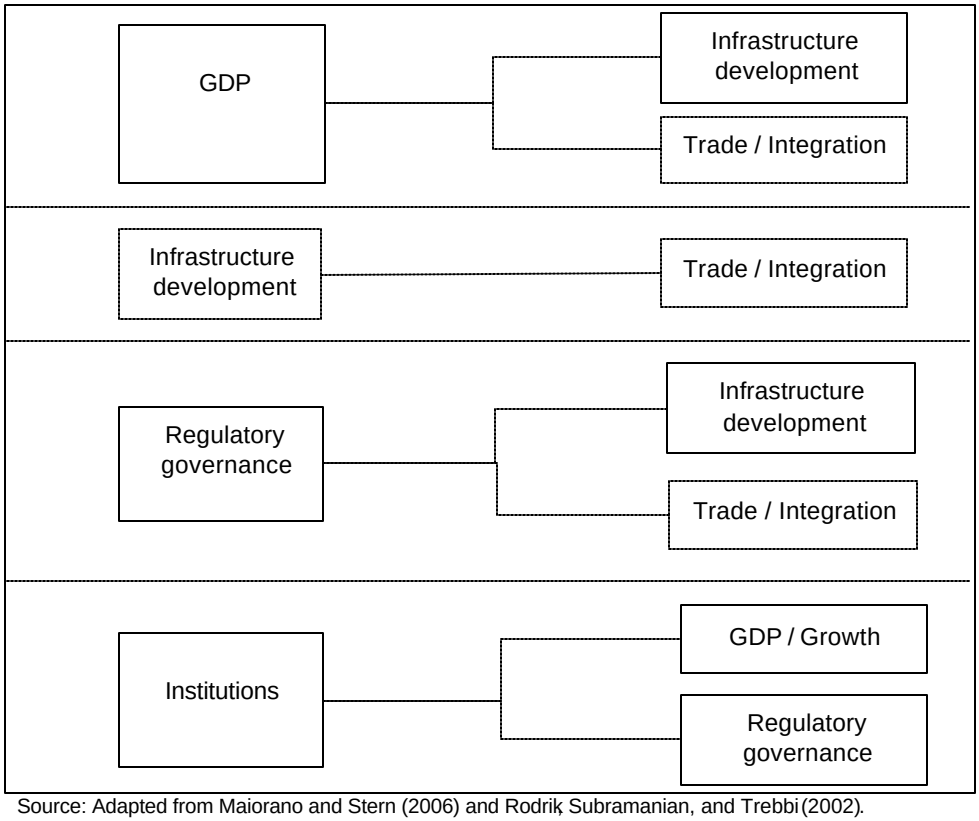
Source: Author's own calculation.

7. DETERMINANTS OF REGIONAL INFRASTRUCTURE

In the previous section, I demonstrated that governance and institutions are positively correlated with infrastructure development. However, thus far I have not examined the functional relationship between governance and infrastructure, while controlling for exogenous factors. I therefore try to verify whether governance influences regional infrastructure development in interactions with other exogenous variables.

The bivariate associations discussed in the previous sections indicate that governance (institution quality) has a positive and significant effect on income and infrastructure. As Figure 1 indicates, trade (integration) can also have a positive impact on governance, infrastructure, and output, suggesting that trade (integration) can have an indirect effect on incomes by improving institutional and infrastructure qualities. Figure 11 better captures this complex interplay among these variables.

Figure 11: Factors Potentially Affecting Regional Infrastructure Development



Source: Adapted from Maiorano and Stern (2006) and Rodrik, Subramanian, and Trebbi (2002).

In order to find the probable determinants of regional infrastructure, I defined regional infrastructure as a product of (i) the scale and structure of country's economic size; (ii) domestic and international demand, through production and international trade; and (iii) governance in institutions, among others. I then estimated the following baseline equation:

$$Infra_{it} = a_0 + a_i + b_1 Gov_{it} + b_2 X_{it}^{'} + b_3 Region_{it} + e_i \quad (1)$$

where *i* represents a country, *t* time and e_i is the error term. The dependent variable *Infra,* is the PII representing regional infrastructure. *Gov* is a composite measure of governance (represented by the governance index), *X* is a vector of additional regressors, and *Region* is a dummy variable representing geographical regions with regional infrastructure : (i) Asia (=1 for Asian countries, 0 otherwise); (ii) Europe (=1 for European countries, 0 otherwise); and (iii) Latin America (= 1 for Latin American countries, 0 otherwise).[24] Additional regressors (*X*) include some control variables to represent internal and external demand for infrastructure, such as per capita income, population, industry and trade. All regressions include country fixed effects (a_i).

I introduced an interactive term between *Gov* and *Region* to examine the impact of regional governance on regional infrastructure development. Equation (1) then becomes:

$$Infra_{it} = a_0 + a_i + b_1 Gov_{it} + b_2 X_{it}^{'} + b_3 Region_{it} + b_4 (Gov_{it} * Region_{it}) + e_i \quad (2)$$

The base year for all the variables is 2006, except otherwise mentioned. I included all countries for which data is available for the dependent and independent variables. That left

[24] In my analysis, I consider the Asia-Pacific members of Asian Development Bank (ADB) as Asia, European members of the EU as Europe, and Latin American members of Inter-American Development Bank as Latin America.

us with a sample of 98 countries, a relatively large dataset for this type of exercise. Moreover, I included all 16 EAS countries and 35 Asia-Pacific members of ADB, to represent the region Asia in this analysis.

Since there are significant and systematic variations in infrastructure development across countries, a satisfactory model should explain substantial heterogeneity at the country level. Using cross-section pooled data can better explain the relevant relationships between regional infrastructure and governance over time when I have both time-variant and time-invariant regressors; because of its structural nature, it will take a long time before the potential impact of infrastructure development on the economy is realized. The use of cross-section pooled data also has the advantage of better capturing the dynamic relationship between endogenous and exogenous variables, by introducing more variability, less collinearity, more degrees of freedom, and more efficiency. I therefore tested the baseline equation (2) using both cross-section (2006) and cross-section and pooled (1996 and 2006) frameworks.

Given the bivariate associations discussed in the previous section, I have yet to ascertain the functional relationship between endogenous and exogenous variables. To do this, I used both the linear (OLS) and non-linear (ordered probit) models. To check the relative robustness of the model, I replaced the PII with the infrastructure index of the WEF, for the cross-section analysis. I selected Generalized Least Squares (GLS) in Model 2 for two technical reasons: (i) the Hausman test (1978) rejected fixed effect (OLS) and select random effect (GLS), and (ii) GLS provided a higher R-squared, compared to OLS. Estimation results are presented in Tables 8 and 9.

Table 8: Baseline Regression Results I: Cross-section, 2006

	OLS(PII)	OLS(WEF)	OP (PII)
	2.010***	0.633***	0.355
Governance	(4.48)	(4.182)	[0.859]
	1.732***	0.428***	1.034***
Ln Per capita income	(8.18)	(6.602)	[5.011]
	0.513***	0.184***	0.143
Ln Population	(3.679)	(4.466)	(1.141)
	0.00455	0.00273***	-0.00135
Trade openness	(1.117)	(2.795)	[-0.342]
Manufacturing value added	0.00664	0.00371	0.0165
	(0.212)	(0.438)	[0.651]
	0.697	0.0742	0.307
Asia (35)	(1.416)	(0.512)	(0.704)
	1.064	0.890***	0.513
Europe (EU) (27)	(1.113)	(3.430)	[0.538]
	-2.912***	-0.466***	-1.218**
Latin America (LA) (20)	(-4.456)	(-2.934)	(-2.262)
	0.707	-0.133	-0.285
Governance*Asia	(1.377)	(-0.850)	[-0.522]
	2.022**	0.539**	0.209
Governance*EU	(2.441)	(2.391)	(0.156)
	-1.455	-0.242	-0.0918
Governance*LA	(-1.570)	(-1.074)	(-0.124)
	0.023***	0.021***	0.022
Distance from equator	(4.651)	(4.235)	[1.431]
Adjusted R^2	0.898	0.841	
Pseudo R^2			0.555
F (Prob>F)	78.38 (0.00)	57.44 (0.00)	
Wald chi2 (Prob > chi2)			119.52 (0.00)
Observations	98	118	98

Note: 1. OP (Ordered Probit): 3=Best (high), 2= Good (medium), 1 = Worst (low). 2. ***, **, and * represent statistical significance at 1%, 5%, and 10% level. Figures in first and third brackets represent the t- and z- statistics, respectively.

Source: Author's own calculation.

Table 9: Baseline Regression Results II: Cross-section Pooled, 1996 and 2006

	GLS REM (PII)	OP (PII)
Governance	0.851	0.0226
	(1.601)	[0.079]
Ln Per capita income	2.055***	1.001***
	(10.27)	(6.494)
Ln Population	0.0108	0.0244
	(0.175)	[0.386]
Trade openness	0.00326	0.0013
	(0.764)	(0.476)
Manufacturing value added	0.0161	0.0576***
	(0.56)	(2.694)
Asia (time variant)	0.392	0.114
	(0.674)	[0.397]
Europe (EU) (time variant)	0.0363	1.853***
	(0.0595)	(4.426)
Latin America (LA) (time variant)	-3.357***	-1.343***
	(-5.341)	[-5.616]
Governance*Asia	0.868	0.297
	(1.319)	(0.998)
Governance*EU	1.738*	8.728***
	(1.669)	(4.784)
Governance*LA	-1.308	0.178
	(-1.636)	(0.581)
Distance from equator	0.045**	0.051
	(2.355)	[1.010]
R^2	0.812	
Pseudo R^2		0.578
Wald chi2 (Prob > chi2)	570.69 (0.00)	129.22 (0.00)
Selection of model		
Hausman test	0.215	
chi2 (Prob>chi2)	0.086	
Observations	192	192
No of countries in sample	99	99
Country effect	Yes	Yes
Year effect	Yes	Yes

Note: 1. OP (Ordered Probit): 3=Best (high), 2= Good (medium), 1 = Worst (low). 2. ***, **, and * represent statistical significance at 1%, 5%, and 10% level, while figures in parentheses represent the t-and z-statistics. 3. Selection of random effect (GLS) over fixed effect is based on Hausman test (1978).

Source: Author's own calculation.

Table 10a: Baseline Regression Results I: Cross-section, 2006 OLS (PII)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln Per capita income	0.135**	0.133***	0.132***	0.140***	0.137***	0.131***
	(12.170)	(15.260)	(11.820)	(20.210)	(19.610)	(11.090)
Ln Population	0.432***	0.349**	0.326***	0.202*	0.276*	0.673**
	(3.180)	(2.761)	(3.347)	(2.132)	(1.880)	(2.524)
Manufacturing value added	0.111***	0.110***	0.0883***	0.127***	0.116***	0.123***
	(4.550)	(4.380)	(3.540)	(4.640)	(4.520)	(4.920)
Trade openness	0.002	0.002	0.001	0.003	0.028*	0.001
	(0.700)	(0.620)	(0.390)	(1.010)	(1.910)	(0.480)
Asia (35)	0.403	0.304	0.310	0.399	0.512	0.504
	(1.010)	(0.740)	(0.790)	(0.890)	(1.220)	(1.230)
Europe (27)	1.628***	1.392***	1.706***	2.126***	1.296**	1.735***
	(3.490)	(2.780)	(3.760)	(4.130)	(2.410)	(3.620)
Latin America (20)	-0.622	-0.950*	-0.878*	-0.846	-1.260**	-0.965*
	(-1.210)	(-1.810)	(-1.750)	(-1.480)	(-2.290)	(-1.830)
Rule of law	1.395***					
	(4.820)					
Regulatory quality		1.192***				
		(4.200)				
Government effectiveness			1.546***			
			(5.260)			
Political Stability				0.119		
				(0.520)		
Voice and accountability					0.860***	
					(3.520)	
Control of corruption						1.268***
						(4.090)
Distance from equator	0.011***	0.093***	0.054**	0.067**	0.045***	0.076*
	(3.132)	(3.871)	(2.972)	(2.652)	(3.450)	(2.002)
Adjusted R^2	0.928	0.924	0.931	0.910	0.920	0.924
Observations	98	98	98	98	98	98

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10% level. Figures in brac ket represent the t-statistic.

Source: Author's own calculation.

Table 10b: Baseline Regression Results I: Cross-section, 2006
Ordered Probit (PII)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln Per capita income	0.367**	0.371**	0.378*	0.328***	0.356***	0.377**
	[3.110]	[3.410]	[2.970]	[4.070]	[4.090]	[3.200]
Ln Population	0.113	0.109	0.126	0.131	0.111	0.138
	(1.037)	(1.040)	(1.041)	(1.087)	(1.098)	(1.035)
Manufacturing value added	0.078*	0.077*	0.067*	0.089*	0.082*	0.079*
	[2.470]	[2.410]	[2.110]	[2.360]	[2.580]	[2.450]
Trade openness	0.002	0.003	0.002	0.006	0.004	0.002
	[0.450]	[0.550]	[0.450]	[1.320]	[0.800]	[0.530]
Asia (35)	0.020	-0.065	-0.030	-0.214	0.078	0.058
	[0.040]	[-0.140]	[-0.070]	[-0.420]	[0.170]	[0.120]
Europe (27)	1.366*	1.160	1.322*	1.661*	0.913	1.400*
	[2.310]	[1.910]	[2.340]	[2.590]	[1.400]	[2.320]
Latin America (20)	-0.440	-0.590	-0.554	-0.604	-0.871	-0.584
	[-1.010]	[-1.440]	[-1.400]	[-1.400]	[-1.950]	[-1.420]
Rule of law	0.605					
	[1.730]					
Regulatory quality		0.479				
		[1.520]				
Government effectiveness			0.848*			
			[2.070]			
Political stability				-0.382		
				[-1.640]		
Voice and accountability					0.509*	
					[2.130]	
Control of corruption						0.498
						[1.440]
Distance from equator	0.030	0.064	0.034	0.021	0.028	0.033
	[1.228]	[1.112]	[1.862]	[1.231]	[1.654]	[1.481]
Pseudo R2	0.595	0.590	0.607	0.591	0.598	0.587
Observations	98	98	98	98	98	98

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10% level. Figures in bracket represent the z-statistic.

Source: Author's own calculation.

Table 11a: Baseline Regression Results II: Cross-section Pooled. 1996 and 2006, OLS (PII)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln Per capita income	0.1367***	0.1374***	0.1426***	0.1358***	0.1442***	0.1412***
	(16.18)	(16.55)	(22.67)	(15.68)	(25.05)	(25.29)
Ln Population	0.0145	0.0142	0.0154	0.0133	0.0132	0.0121
	(0.172)	(0.170)	(0.176)	(0.167)	(0.167)	(0.163)
Manufacturing Value added	0.126***	0.109***	0.122***	0.0961***	0.127***	0.113***
	(6.251)	(5.328)	(5.812)	(4.667)	(6.006)	(5.647)
Trade openness	0.00142	0.00145	0.00184	0.00102	0.00205	0.00514*
	(0.531)	(0.542)	(0.658)	(0.389)	(0.716)	(1.928)
Asia (time variant)	0.148	0.0962	0.155	-0.225	-0.0236	0.0543
	(0.447)	(0.288)	(0.444)	(-0.684)	(-0.0672)	(0.164)
Europe (time variant)	0.591	0.762*	0.893*	0.681	1.098**	0.355
	(1.337)	(1.722)	(1.913)	(1.561)	(2.391)	(0.772)
Latin America (time variant)	-1.531***	-1.289***	-1.588***	-1.404***	-1.342***	-1.771***
	(-3.623)	(-3.025)	(-3.495)	(-3.356)	(-3.002)	(-4.120)
Control of corruption	1.089***					
	(4.773)					
Rule of law		1.071***				
		(4.553)				
Regulatory quality			0.500**			
			(2.359)			
Government effectiveness				1.280***		
				(5.305)		
Political stability					0.244	
					(1.313)	
Voice and accountability						0.925***
						(4.993)
Distance from equator	0.034***	0.038***	0.037***	0.031***	0.039***	0.038***
	(4.345)	(4.453)	(4.450)	(4.165)	(4.309)	(4.451)
Adjusted R^2	0.900	0.897	0.888	0.901	0.886	0.899
Observations	189	192	192	192	192	192
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10% level. Figures in bracket represent the t-statistic.

Source: Author's own calculation.

Table 11b: Baseline Regression Results II: Cross-section Pooled, 1996 and 2006 Ordered Probit (PII)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln Per capita income	0.1292***	0.1256***	0.1273***	0.1244***	0.1317***	0.1287***
	[6.103]	[5.564]	[6.313]	[5.385]	[6.975]	[6.88]
Ln Population	0.0241	0.0218	0.0276	0.0235	0.0241	0.0252
	[0.325]	[0.338]	[0.322]	[0.331]	[0.308]	[0.311]
Manufacturing Value added	0.107***	0.0893***	0.0909***	0.0860***	0.0977***	0.0924***
	[5.724]	[5.071]	[5.171]	[4.786]	[5.569]	[5.295]
Trade openness	0.00312	0.000493	0.000931	0.000896	0.00244	0.00147
	[0.918]	[0.149]	[0.285]	[0.271]	[0.726]	[0.449]
Asia (time variant)	-0.414	-0.285	-0.326	-0.343	-0.337	-0.249
	[-1.462]	[-1.037]	[-1.176]	[-1.233]	[-1.205]	[-0.899]
Europe (time variant)	1.143*	1.185*	1.074*	1.116*	1.337**	0.944
	[1.832]	[1.914]	[1.716]	[1.795]	[2.153]	[1.462]
Latin America (time variant)	-0.857**	-0.741**	-0.871**	-0.776**	-0.801**	-0.933***
	[-2.444]	[-2.144]	[-2.467]	[-2.227]	[-2.316]	[-2.604]
Control of corruption	0.0893					
	[0.411]					
Rule of law		0.325				
		[1.595]				
Regulatory quality			0.224			
			[1.256]			
Government effectiveness				0.462**		
				[2.082]		
Political stability					-0.19	
					[-1.275]	
Voice and accountability						0.270*
						[1.711]
Distance from equator	0.0232	0.0261	0.0287	0.0254	0.0276	0.0292
	[0.867]	[0.993]	[1.109]	[1.032]	[1.103]	[1.001]
Pseudo R^2	0.576	0.562	0.559	0.566	0.560	0.563
Observations	189	192	192	192	192	192
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10% level. Figures in bracket represent the z-statistic.

Source: Author's own calculation.

The following results bear highlighting. First, the linear models with PII as dependent variable are a better fit; both models explain 81-90% of the variation in observations. The basic results of the estimation were as expected—most of the estimated coefficients are statistically significant and robust, with the correct signs and magnitudes. The good fit in both models tell us that good governance positively influences the development of regional infrastructure: every one point improvement in governance leads to a two point rise in regional infrastructure in Model 1 (Table 8), and a 0.85 increase in Model 2 (Table 9). At the sample average of the index of governance -0.04, and the value of the coefficient 2.010 (in

Model 1, Table 8) and 0.851 (in Model 2 in Table 9) in the baseline regression, the size of the effect with respect to the index of governance would vary between 1 to 2 points.

Second, the significant and positive interaction term (Governance*EU) in both models suggest that, other things being equal, membership in the EU is not critical for the development of regional infrastructure; what is important is the introduction of good governance in the region. The results for Latin America are completely opposite, while the results for Asia fall somewhere in between. The results imply that appropriate institutions and policies are required for effective governance and regional infrastructure development. In the case of the EU, they also suggest a degree of regional diffusion—taken together, regional institutions and governance have a direct and positive effect on the local governance of each country in the region, which in turn facilitates regional infrastructure development. However, the negative coefficient of the Latin America dummy (highly significant in both models) implies that membership in regional institutions alone has not helped the development of regional infrastructure in Latin America. It also suggests that the region has yet to significantly improve regional governance.

Third, in both models and for both periods, the results remain largely unchanged even after I replaced the aggregate governance index with its individual components as regressors (Tables 10 and 11). The one exception was political stability, which had a negative but statistically insignificant coefficient. Interestingly, it is government effectiveness which had the strongest influence on regional infrastructure: a one point improvement in government effectiveness may lead to a rise of 1.28 to 1.55 points in regional infrastructure, *ceteris paribus*. The most striking result is the significance of the EU dummy. The Asia dummy appeared with a negative sign, but was not statistically significant. These results suggest that government effectiveness, rule of law, regulatory quality, control of corruption, and voice and accountability are all important determinants of regional infrastructure development.

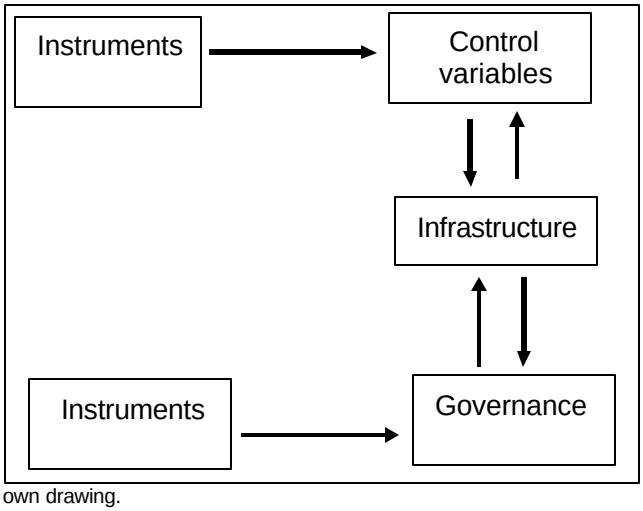
Tables 9 and 10 show that income levels are highly significant for regional infrastructure development. Population is likewise revealed to be significant. Trade and manufacturing did not come out as significant in the models, although they had the correct signs. This may be the result of income and population (and also their variations) neutralizing the significance of trade and manufacturing in the models. The results also suggest that a country's growth is just as important as governance (both at the national and regional level) for regional infrastructure development.

To conclude, countries (and regions) with higher income, stronger institutions, better governance, and more open economies are likely to have higher levels of regional infrastructure. Indirectly, the estimated results of the baseline models also suggest that that our efforts to promote regional infrastructure must not be limited to traditional policy measures aimed at attracting investment in infrastructure, but must also address policy reform across a number of areas. Thus, institutions and governance must play an important complementary role in strengthening Asia's regional infrastructure.

Robustness checks

The relationships described above cannot be interpreted as causal until I rule out the possibility of endogeneity in equation (2). To address this problem, I used a dynamic GMM estimator (system-GMM) to analyze changes across countries and over time. The estimator also effectively deals with reverse causality by using a set of instruments for the endogenous variables, and includes the lagged dependent variable to account for the persistence of the infrastructure indicator.

Figure 12: Estimation Strategy



Source: Author's own drawing.

One of the main advantages of the system-GMM estimator is that it does not require any external instruments other than the variables already included in our dataset. It uses lagged levels and differences between two periods as instruments for current values of the endogenous variable, along with external instruments. For the infrastructure index and the period 1996 and 2007, for example, the system-GMM method uses the following as instruments: (i) levels of infrastructure for the periods 1995 and 2006 and earlier; and (iii) differences in infrastructure, namely, differences between the periods 1995 and 1996, and 2006 and 2007. More importantly, the estimator does not use lagged levels or differences by itself for the estimation, but rather employs them as instruments to explain variation in infrastructure development. This approach ensures that all information will be used efficiently, and that focus is given to the impact of regressors (such as governance) on infrastructure, and not vice versa.

For this analysis, I started with a relatively simple specification:

$$Infra_{it} = a_i + b_1 Infra_{i\,t-1} + b_2 Infra_{i\,t-2} + b_3 Gov_{it} + g' X_{it} + l' Z_{it} + e_{it} \qquad (3)$$

where the variables are same as in the previous models, except for two additions in equation (3): (i) $Infra_{it-1}$ and $Infra_{it-2}$, which represent the lagged dependent variable in the previous period, and (ii) Z_{it} is a set of instruments for Gov_{it} and X_{it}. Here, Gov_{it} is the variable of interest. X_{it} denotes the set of control variables, and e_{it} stands for the error term. Estimating equation (3) by OLS for the typical pooled cross-country time series analysis with "small T and large N" is likely to produce biased coefficients, if the independent variable is endogenous. As a remedy, I followed the procedure suggested by Arellano and Bond (1991) and, as a first step, eliminated the country-specific effects using first differences:

$$\Delta Infra_{it} = \alpha_i + \beta_2 \Delta Infra_{i_{t-2}} + \beta_3 \Delta Gov_{it} + \gamma' \Delta X_{it} + \lambda' \Delta Z_{it} + \Delta \varepsilon_{it} \qquad (4)$$

where ?$Infra_{it}$ = $Infra_{it}$ – $Infra_{it-1}$. As a second step, I estimated equation (4) using system-GMM.[25] The system-GMM approach estimates equations (3) and (4) simultaneously, by using lagged levels and lagged differences as instruments.[26] I favored the system-GMM

[25] By following this approach, I obtained the Arellano and Bond difference-GMM estimator. This estimator, which can be viewed as an extension of the Anderson and Hsiao (1982) estimator, produces efficient (and consistent) estimates; the latter estimator fails to take all the potential orthogonality conditions into account.

[26] In two later papers, however, Arellano and Bover (1995) and Blundell and Bond (1998) revealed a potential weakness of the difference-GMM estimator. They showed that lagged levels can be poor instruments for first-

estimator, as *Infra* is very likely to be persistent. Because I used lagged levels and lagged differences, the number of instruments can be quite large in a system-GMM estimator. I used 15 instruments in the analysis. I also report the results of IV regressions (2SLS). To test the appropriateness of the instruments used, I used the Sargan test of over-identifying restrictions in the case of 2SLS, and Hansen J statistics in case of system-GMM in Table 12. The Sargan and J- statistics show that the applied instruments are valid. The estimation results are reported in Table 12.

The following observations are worth mentioning. First, the signs and statistical significance of the coefficients confirm the results obtained for regional infrastructure development in Tables 8 and 9. Moreover, the results obtained in the 2SLS and system-GMM are very similar to each other, except for the size of the coefficients. In the 2SLS, governance (and institutional quality) remains a strong predictor of regional infrastructure development, despite the fact that the magnitude of its coefficient is lower compared to the estimates obtained in equation (2). On the other hand, the coefficient for governance is much bigger in the system-GMM in equation (4). The results have therefore improved compared to those reported in Table 9, an indication of the general robustness of the relationship between regional infrastructure and governance.

Second, I find substantial improvements in the results for the dummy variable Asia and its corresponding interaction term in equation (4), compared to equation (2). The interaction term in equation (4) yielded the best results in terms of significance and the overall explanatory power of the regressions. The estimated coefficients for Asia and the interaction term are significant at the 5% level in the 2SLS and at the 10% level in the system-GMM, thereby suggesting that (i) national and regional governance must move in parallel in order to have optimal regional infrastructure development in Asia; and (ii) regional governance is perhaps more important than national governance, for regional infrastructure to develop in Asia. A one point improvement in regional governance would lead to roughly a two point increase in regional infrastructure in Asia, other things being equal. With the average of the index of governance (-0.04), the size of the effect with respect to the index of governance would vary between 1 to 1.5.[27]

Third, when the governance index takes on a negative value (in the range -2.5 to +2.5), the interaction term (*Gov**Asia) actually becomes negative. This suggests that, in the case of corrupt countries with inefficient governments and weak institutions or governance, regional infrastructure may not facilitate integration with the international market.

differenced variables, particularly if the variables are persistent. In their modification of the estimator, they suggested the inclusion of lagged levels along lagged differences. In contrast to the original difference- GMM, they termed this the expanded estimator system-GMM.

[27] Governance refers to the scale of -2.5 to +2.5.

Table 12: Determinants of Infrastructure (PII)

	2SLS	System-GMM
Infrastructure (t-1)	0.652***	0.947***
	[3.765]	[5.048]
Infrastructure (t-2)	-0.267*	-0.272*
	[-1.421]	[-1.890]
Governance	1.033*	1.513*
	[1.560]	[1.780]
Ln Per capita income	1.044***	0.686*
	[3.390]	[1.820]
Ln Population	0.085	0.155*
	[0.890]	[1.480]
Trade openness	0.002	0.003
	[0.200]	[0.290]
Manufacturing value added	0.098**	0.128***
	[2.580]	[3.400]
Asia	1.757**	1.567*
	[2.420]	[2.110]
Europe	2.116**	1.165*
	[2.270]	[1.330]
Latin America	-1.608**	-1.434**
	[-2.810]	[-2.760]
Governance*Asia	2.272**	1.876*
	[2.450]	[1.860]
R^2	0.8182	0.7966
Wald chi2 (Prob > chi2)	242.37	288.95
Test of over-identification		
Sargan chi2 (Prob > chi2)	18.6532 (0.0048)	
Hansen's J chi2 (Prob > chi2)		12.4553 (0.0031)
Instruments	Yes (15)	Yes (15)
Country effects	Yes	Yes

Note: ***, **, and * represent statistical significance at 1%, 5%, and 10% level. Figures in third brackets represent the z- statistic. Statistically insignificant instruments are not reported in the results.

Source: Author's own calculation.

Table 13: Country-level Average Size of Governance Effect on Regional Infrastructure in Asia*

Country	National Governance	Regional Governance	Total
Afghanistan	-0.170	0.193	0.024
Armenia	1.172	1.535	2.706
Australia	3.113	3.476	6.589
Azerbaijan	0.644	1.007	1.650
Bangladesh	0.565	0.928	1.493
Bhutan	1.869	2.232	4.101
Brunei	1.910	2.273	4.183
Cambodia	0.651	1.014	1.664
China, People's Rep.	0.950	1.313	2.262
Fiji	1.268	1.631	2.899
Hong Kong, China	2.964	3.327	6.290
India	1.367	1.730	3.098
Indonesia	0.889	1.252	2.142
Japan	2.748	3.111	5.860
Kazakhstan	0.885	1.248	2.132
Korea, Republic of	2.146	2.509	4.656
Kyrgyz Republic	0.566	0.929	1.494
Lao PDR	0.571	0.934	1.506
Malaysia	1.868	2.231	4.099
Maldives	1.444	1.807	3.251
Mongolia	1.408	1.771	3.179
Myanmar	-0.144	0.219	0.074
Nepal	0.523	0.886	1.409
New Zealand	3.281	3.644	6.924
Pakistan	0.576	0.939	1.515
Philippines	1.034	1.397	2.431
Singapore	2.989	3.352	6.340
Sri Lanka	1.122	1.485	2.607
Tajikistan	0.392	0.755	1.148
Thailand	1.290	1.653	2.943
Turkmenistan	0.074	0.437	0.512
Uzbekistan	0.051	0.414	0.466
Viet Nam	0.948	1.311	2.260

Note: *Counts system-GMM estimates.

Source: Author's own calculation.

Table 14: Marginal Effects of Governance on Regional Infrastructure

Item	Regional Infrastructure	
	2SLS	System-GMM
Total effects	4.316	4.316
National governance in Asia	4.339	4.329
Regional governance in Asia	4.144	4.329
Change in 1 percentage point in Governance Index (GI)	5.198	5.505

Source: Author's own calculation.

Fourth, the size of country-level governance effects on regional infrastructure varies between 0.02 and 6.92 (Table 13).[28] Improvements in regional governance have a greater effect on regional infrastructure development (between 3.64 and 0.19), compared to improvements in national governance (between -0.17 and 3.28) in Asia. In some cases, deficiencies in national governance may be overcome if these are complemented by improved regional governance, *ceteris paribus*.

Finally, the total average effect of governance, which depends on these complex interactions, can be estimated by calculating the marginal effects. To facilitate the interpretation of the results in Table 12, I computed the marginal effects for the variables of interest.[29] Given the underlying equation (3), these marginal effects can be interpreted as variations relative to the mean value at a given income level. In other words, they quantify the observed improvement in regional infrastructure when a country has improved governance, relative to other countries at the same income level. The estimated marginal effects further strengthen our arguments: both national and regional governance facilitates regional infrastructure development.

8. CONCLUSIONS

In this study, I have performed a comprehensive empirical analysis of the linkages between governance and infrastructure development. Our results indicate that governance is crucial for regional infrastructure development, and therefore beneficial to all Asian countries. Good governance helps unlock the full economic potential of a region or nation; more effective policy approaches toward improved governance are therefore needed to complement regional infrastructure development initiatives in Asia.

The results of the analysis show that the linkages between regional infrastructure and governance are multiple and complex. The results also make it abundantly clear that governance reform is a key factor affecting regional infrastructure development: every one point increase in governance would lead to 1 to 1.5 rise in regional infrastructure in Asia.

The findings of this study suggest that, other things being equal, membership in regional organisations is not critical for developing regional infrastructure. What matters is good governance (as in the case of the EU).

Countries and regions with higher income, stronger institutions, better governance, and more open economies are likely to have higher levels of regional infrastructure. The estimated marginal effects calculated in this paper further evince that governance—both national and regional—facilitates regional infrastructure development.

The results of the analysis also imply that our efforts to promote regional infrastructure must not be limited to traditional policy measures aimed at attracting investment in infrastructure, but must also address policy reform across a number of areas. Thus, institutions and governance must play an important complementary role in strengthening Asia's regional infrastructure.

Given the complexity of institutional reform and the slow pace of improvements in governance, progress in infrastructure development is unlikely to be incremental in many Asia countries. As such, improving governance at the regional level may be helpful, given the possibility of regional diffusion: our results suggest that regional institution and

[28] Calculated based on *Gov* and *Gov*Asia* coefficients estimated under the system-GMM in the equation (3), and then added to individual country average governance scores.

[29] To compute the marginal effects of *Gov* (or the interaction term) I first calculated the derivate of equation (4) with respect to *Gov* (and interaction term), setting all the other variables to their average value, and then I tested the hypothesis that the derivate is equal to zero.

governance can have a direct and positive effect on the local governance countries in the region, subsequently leading to regional infrastructure development.

An appropriate institutional and policy framework is required for effective governance and regional infrastructure development. Developing countries face significant constraints in improving governance; at the same time, improving governance requires significant lead time and considerable structural adjustments. Poor governance isolates countries from international best practice. Regional cooperation can therefore play an important catalytic role in improving governance at the national level. By allowing countries to share their experiences, regional cooperation can help developing countries learn and benefit from regional and international governance.

Improved governance, particularly at the sectoral level, can carry huge payoffs at a time when Asia is looking for higher investments in infrastructure and greater free trade within the region. Making Asia "seamless" will thus require complementary policy initiatives by countries, regional organizations, and multilateral development organizations in order to strengthen governance in institutions in Asia and beyond.

This study is not without limitations, and a number of issues require further consideration. First, future studies are needed to understand the relationship between disaggregated governance indicators and regional infrastructure sectors such as power, aviation, ports, roads, and railways. Second, an analysis of the causality between governance and infrastructure would also be worthwhile. Third, the analysis presented in this paper could be verified with new governance indicators from alternative sources. Fourth, it would be helpful to explore the manner in which Asian countries can make a positive contribution to improving governance in institutions that support regional infrastructure. Finally, a more sophisticated dynamic analysis may be attempted to verify the findings of this paper.

Efforts should be made to collect representative governance indicators which contain better information. Developing a capacity building and training tool for policymakers on measuring the impact of regional governance on infrastructure development may also be worth considering.

APPENDIX 1: AGGREGATE GOVERNANCE INDICATORS 1996–2007

The composite governance index (GI) was derived from six aggregate indicators that measure perceptions of the following dimensions of governance:

- Voice and Accountability (VA) – the extent to which a country's citizens are able to participate in selecting their government, as well as enjoy freedom of expression, freedom of association, and a free media.
- Political Stability and Absence of Violence (PV) – the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.
- Government Effectiveness (GE) – the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
- Regulatory Quality (RQ) –the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
- Rule of Law (RL) –the extent to which agents have confidence in and abide by the rules of society; the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.
- Control of Corruption (CC) – the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

These indicators were constructed using the unobserved components methodology described in a series of papers by Daniel Kaufmann, Aart Kraay, and Massimo Mastruzzi (Kaufmann, Kraay, and Mastruzzi 2003, 2005, 2006, 2007, 2008). The six governance indicators are measured in units ranging from -2.5 to 2.5, with higher values corresponding to better governance outcomes. Detailed information on the dimensions measured by each indicator, its components, and the interpretation of the point estimates and standard errors can be found in the said papers. The 2008 release of the World Governance Indicators incorporates revisions to data for 1996–2006 as well as new data for 2007.

The governance indicators reflect the statistical compilation of responses on the quality of governance given by a large number of enterprise, citizen and expert survey respondents in industrial and developing countries, as reported by a number of survey institutes, think tanks, non-governmental organizations, and international organizations. Countries' relative positions on these indicators are subject to margins of error that are clearly indicated. Consequently, precise country rankings should not be inferred from this data.

APPENDIX 2

To derive each index, appropriate weights are required for the facilities under each category. A basic limitation of the conventional method of indexation is that it assigns ad hoc and fixed weights to different facilities that may actually vary over time and space, depending on their significance. To overcome this limitation, I have employed the well-known multivariate technique called principal component analysis (PCA) (Fruchter 1967). The rationale for using PCA is that it helps provide an aggregate representation using various individual indicators. Its overall objective is *pari passu* with homogenizing the overall requirements for individual infrastructure facilities across countries.

Before multiplying them with the respective weights derived from "rotated factor loading" of PCA, the raw infrastructure facilities were converted into "unit-free" and "scale-free" values divided by the infrastructure values' (i.e., column-wise) standard deviation, to neutralize the heterogeneity due to varied units. One can also convert the raw infrastructure facilities as "scale-free," dividing by country-wise 'mean', instead of making it "unit free," dividing by country-wise 'standard deviation'. Both methods have advantages and disadvantages. In this study, I have used PCA to select the set of infrastructure variables which can best represent the status of infrastructure at the country-level.

PCA has been used for two purposes: (i) to derive weights for each infrastructure facility, and (ii) to eliminate redundant variables and generate a robust index. The construction of the infrastructure composite index serves both purposes. In the PCA approach, the first principal component is that linear combination of the weighted facilities that explain the maximum of variance across the observations at a point in time. One may continue looking at subsequent factor loadings until variance is maximized (by looking at scores of Eigen values).

Factor Loadings of PCA

	Component 1	Component 2
Roadways	0.256	0.563
Railways	0.162	-0.022
Airports	0.322	0.166
Seaports	0.503	-0.047
Telecommunications	0.389	-0.003
Electricity	0.380	0.003
Eign value (expl. var.)	3.650	1.543
Prp. total (%)	0.589	0.702

APPENDIX 3

Physical Infrastructure Index (PII)

Indicators	Definition	Source
Roadways	Road (paved) length per sq. km of surface area	Asian Infrastructure Database (AID), based on World Development Indicators, various issues, and other miscellaneous sources.
Railways	Railway length per sq. km. of surface area	
Airports	Air passengers carried per 100,000 population	
Seaports	Sea cargo (container) carried per seaport	AID, based on Containerization International, various issues
Telecommunications	Telecommunication fixed and mobile lines per 10,000 population	AID, based on World Development Indicators, various issues, and other miscellaneous sources.
Electricity	Per capita consumption of electricity	

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