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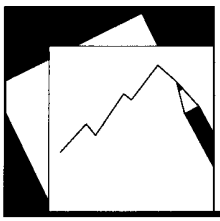

IMF Working Paper

Infrastructure and Income Distribution in ASEAN-5: What are the Links?

Dulani Seneviratne and Yan Sun

 WP/13/41

IMF Working Paper

Asia and Pacific Department

Infrastructure and Income Distribution in ASEAN-5: What are the Links?

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Authorized for distribution by Alexandros Mourmouras

February 2013

Abstract

Adequate infrastructure has long been viewed as an important factor in economic development. Based on regressions covering 76 advanced and emerging market economies, this paper estimates the impact of infrastructure and investment on income distribution. It finds that better infrastructure, both quality and quantity, promotes income equality, while the link between investment and income distribution is weak.

JEL Classification Numbers: H54, D31, E22, O53

Keywords: Infrastructure, Income Distribution, Investment, ASEAN-5, GINI, Inclusive Growth

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I. INTRODUCTION

The ASEAN-5[2] countries, while among the fastest growing regions in the world, still face the challenge of overcoming infrastructure bottleneck to a varying degree. The infrastructure gaps are relatively bigger in Indonesia, the Philippines, and Vietnam than in the other two, which have higher per capita income. One likely contributing factor is the drop in the investment rate following the Asian crisis. While economic activity in the ASEAN-5 has largely rebounded to pre-crisis levels, investment as a share of GDP has never fully recovered in most of these countries (Figure 1). In addition, limited fiscal space and weaknesses in business climate as well as in budget execution may have contributed to the infrastructure bottleneck in some countries.

With robust growth, the ASEAN-5 countries have made great strides in poverty reduction. Their poverty levels have come down significantly since the early 1990s. However, challenges remain. From a cross-country perspective, Indonesia, the Philippines, and Vietnam still have sizable populations living below the poverty line, while extreme poverty has become almost non-existent in Malaysia (Figure 2). In terms of income distribution, Malaysia and Thailand have somewhat higher Gini indices than others. Moreover, average income inequality has modestly increased in the ASEAN-5, as illustrated by the rising Gini index as well as by the decline in the income share held by the lowest quintile. This contrasts with other emerging market economies, which on average experienced some decrease in inequality during recent decades.

Adequate infrastructure has long been viewed as an important input for economic development. There has been solid evidence, at both macroeconomic and microeconomic levels, that infrastructure improves productivity and growth. There is also some empirical evidence that infrastructure helps income equality.[3] In theory, infrastructure development can promote equality through enhancing access to productive opportunities by the poor and disadvantaged. This paper assesses empirically the impact of infrastructure and investment on income distribution, based on regressions covering most advanced and emerging market economies. In doing so, we also analyze the impact of public policies in the areas of education, labor, and financial access on income distribution.

We find that better infrastructure, both quality and quantity, improves income distribution. However, investment alone does not promote income equality, pointing to a likely weak link between investment and buildup of infrastructure. There is evidence that policies to promote education, employment in formal sectors, and financial development can also play useful roles in enhancing equality.

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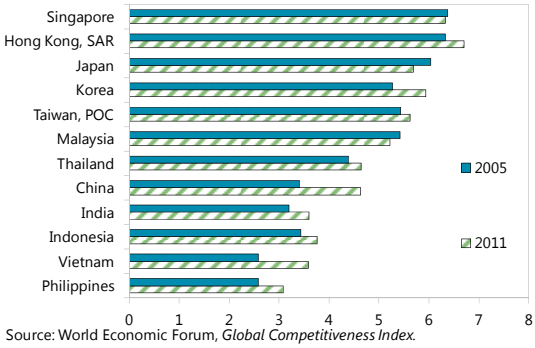
[2] ASEAN-5 in this paper refers to Indonesia, Malaysia, Philippines, Thailand, and Vietnam.

[3] See Calderon and Serven (2004 and 2008).

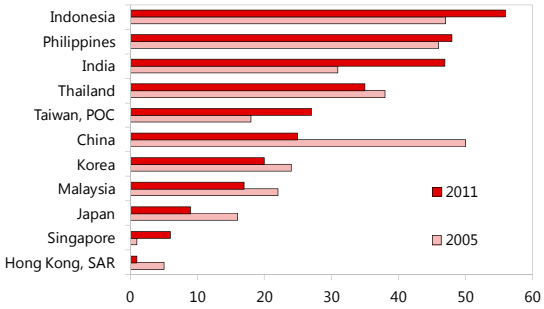
Figure 1. Infrastructure, Investment, and Regulatory Environment

Global Competitiveness Index: Infrastructure 1/



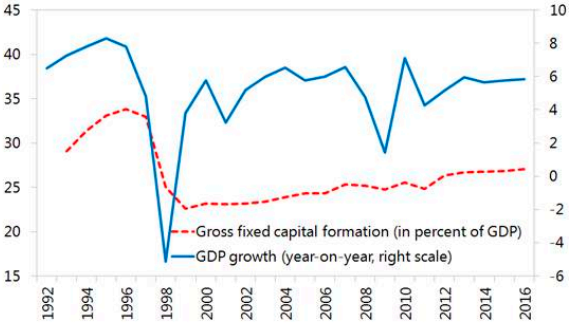
Source: World Economic Forum, *Global Competitiveness Index.*
1/ Ranges from 1-7; a score of 7 indicates the best score.

Basic Infrastructure Ranking 1/



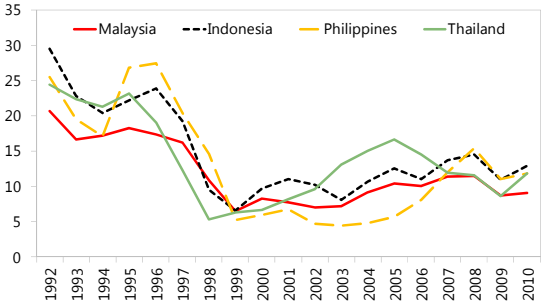
Source: IMD, *World Competitiveness Online.*
1/ A lower ranking indicates a better score out of 51 countries in 2005 and 59 countries in 2011.

ASEAN-5: Gross Fixed Investment and GDP Growth 1/



Sources: IMF, *World Economic Outlook*; CEIC Data Co. Ltd; and IMF staff estimates.
1/ ASEAN-5 includes Indonesia, Malaysia, Thailand, Philippines, and Vietnam.

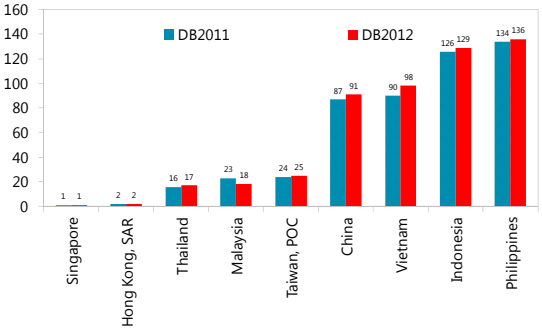
Corporate Investment Rates 1/ (Medians; in percent)



Sources: Worldscope database; and IMF staff estimates.
1/ Capital expenditure to PPE ratio.

Ease of Doing Business

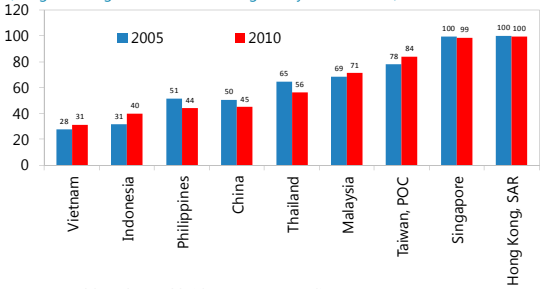
(A lower rank indicates a better business environment)



Source: World Bank, *Doing Business Database* 2011.

CPIA Rating: Regulatory Quality

(A higher rating indicates a better regulatory environment)

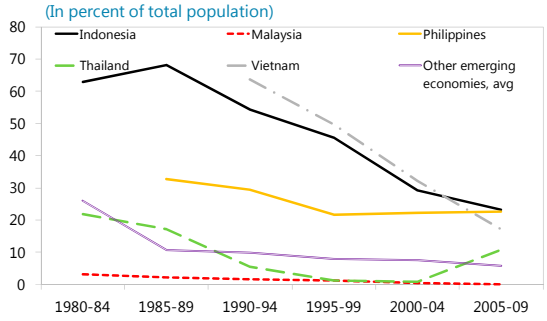


Source: World Bank, *Worldwide Governance Indicators.*
1/ Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

Figure 2. Poverty and Income Distribution

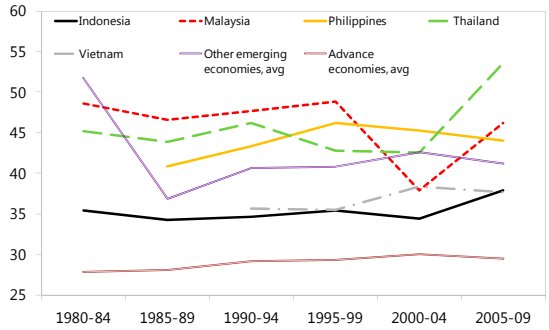
Poverty Headcount at US$1.25 per day

(In percent of total population)



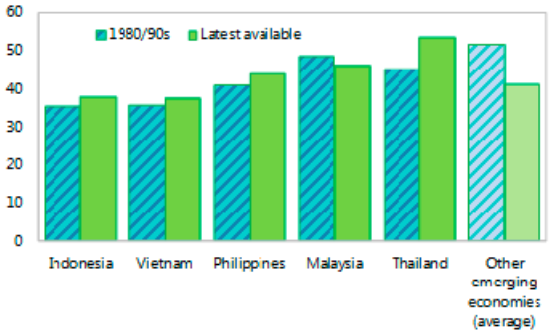
Sources: World Bank, *World Development Indicators*; and IMF staff estimates.

GINI Index



Sources: World Bank, *World Development Indicators* and *Povcal* databases; OECD and LIS/EU databases; and IMF staff estimates.

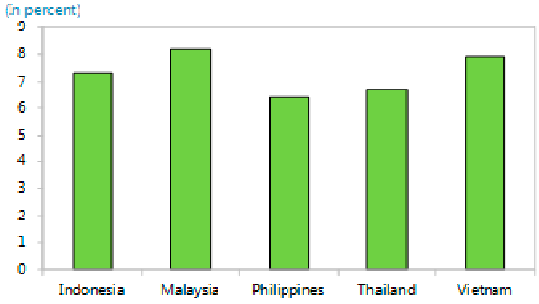
GINI Index



Sources: World Bank, *World Development Indicators* and Povcal databases; OECD and LIS/EU databases; and IMF staff estimates.

PPP adjusted Change in Private Consumption during 1990–2011 1/

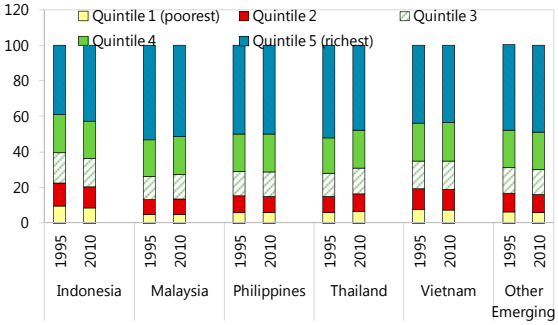
(In percent)



Sources: IMF, World Economic Outlook; and IMF staff estimates.
1/ Calculated as the annual average percent change from 1990 to 2011.

Income Share by Quintile 1/

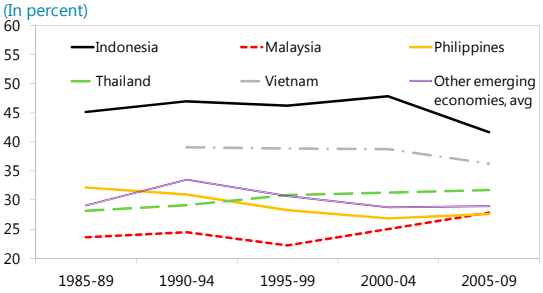
(In percent of total)



Sources: World Bank, *Povcal database*; and IMF staff estimates.
1/ Calculations are based on 5-year averages.

Income of the Lowest 20 Percent Relative to Mean Per Capita Income

(In percent)



Sources: World Bank, *Povcal database*; and IMF staff estimates.

The rest of the paper is organized as follows. Section II presents stylized facts on infrastructure gaps in the ASEAN-5. Section III discusses the methodology and results. The last section concludes with policy discussions.

II. INFRASTRUCTURE DEVELOPMENT IN ASEAN-5

The ASEAN-5 countries have improved infrastructure over the years, but their infrastructure development needs and remedies vary.

- **Indonesia**: Indonesia's GCI ranking on infrastructure has improved during the past five years, yet infrastructure investment lags behind some of its regional peers. For instance, infrastructure quality in terms of transportation and electricity supply could be further enhanced. Public investment in particular remains low in Indonesia. Efficient execution of infrastructure projects is constrained by limitations in project selection at local government levels[4]. Moreover, inefficiencies in implementing infrastructure projects due to weaknesses in the procurement, budget preparation, and payment processes have contributed to low infrastructure investment realization levels.

- **Malaysia**: Infrastructure development is overall better in Malaysia than in many of its ASEAN peers. This is evident by Malaysia's high infrastructure rankings in various indices, including the Global Competitiveness Index (GCI) and the World Competitiveness Yearbook (IMD). Over years, Malaysia has attained a comparative advantage in many basic infrastructure categories including energy infrastructure. In light of Malaysia's stagnated investment rate after the Asian crisis, the authorities have given considerable attention to projects under the Economic Transformation Program as catalyst for sustainable investment growth, concentrated mainly in infrastructure, commodity, and construction sectors[5]. There is room for further improvements to infrastructure quality in the information and communication technologies (ICT) sector[6]. Greater focus on ICT infrastructure at regional levels, particularly in less populous regions, could also reduce regional disparities between urban areas and the rest of the country.

- **The Philippines**: Despite some improvement in recent years, the Philippines' infrastructure rankings remain relatively low among the ASEAN-5. In particular, there is room for improving infrastructure quality related to transportation and electricity. Arulpragasam and Lachler (2011) identify governance as one of the main constraints, in addition to financial and labor market limitations.

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[4] See IMF (2012a).

[5] See IMF (2011b).

[6] See World Bank (2011).

- **Thailand**: The country has improved infrastructure at the national level over the years, as evident in its increasing GCI rankings. Nevertheless, significant regional disparities in infrastructure exist. The private capital accumulation and the allocation of public infrastructure expenditure are unequally distributed and have a strong presence in the Bangkok area[7]. Investment and infrastructure development have improved in the central and eastern regions due to the relative proximity to the capital and location on trade routes. In response to the devastating floods in late 2011, the government rolled out flood-prevention investment, including a B 350 billion (3 percent of GDP) off-budget package for infrastructure investment to be implemented over three years.

- **Vietnam**: Many basic infrastructure indicators illustrate improvements in recent decades. For instance, the length of paved roads has quadrupled during the last ten years, while electricity production capacity has increased by about 10 percent in two decades[8]. In spite of these improvements, Vietnam still faces challenges in reducing the infrastructure gap with its regional peers in some areas. As indicated in the 2012 Global Competitiveness Report, although the length of paved roads has improved over the years, the quality of roads and ports could be significantly improved. The World Bank's 2012 Vietnam Development Report has identified several impediments, with public resource allocation inefficiency being a key constraint. Public sector infrastructure development projects are carried out by rather decentralized institutions of local governments and state-owned enterprises, delaying the implementation of some projects that are of national interest.

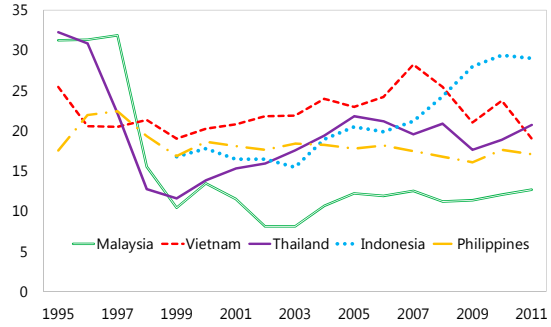
Following the Asian crisis, gross fixed investment has declined significantly in most of the ASEAN-5 economies. Structural primary deficits and large public debt burdens in some ASEAN-5 countries have limited their governments' participation in investment projects and the ability to meet large infrastructure needs[9]. The decline in investment in ASEAN-5 is also driven by the sharp fall in private investment, including foreign direct investment. Private investment commitments in major infrastructure sectors exhibit a similar drop since the Asian crisis (measured in US dollars as well as a share of GDP). Fostering a conducive business environment to attract private infrastructure investment, for example through improving efficiencies in institutional and procedural frameworks, would help close infrastructure gaps in the long run.

[7] See IMF (2012b).

[8] See World Bank (2012).

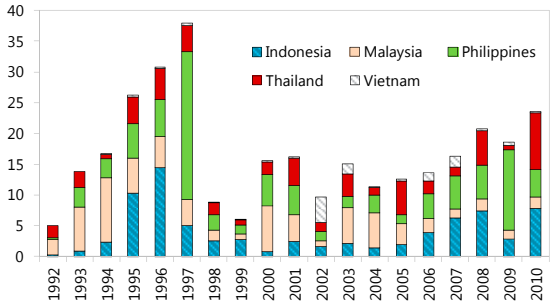
[9] See Budina and Tuladhar (2010).

Private Gross Fixed Investment
(In percent of GDP)



Source: IMF, *World Economic Outlook*.

Investment Commitments to Infrastructure Projects with Private Participation
(In billions of US dollars)



Sources: World Bank; and PPIAF, *PPI Project database*.

III. Methodology and Results

Measuring infrastructure is not straightforward. We follow Calderon and Serven (2004 and 2008) to construct quantitative indices of infrastructure quality and quantity. The two indices try to capture information in three key basic infrastructure sectors—communication, power, and road network—which play an important role in economic development. The infrastructure quantity index is the first principal component of three variables: total telephone lines, cell subscriptions, and internet users per 100 people; electricity production per capita (in millions of KWh); and road density (km of road per 100 sq. km of land area).[10] The infrastructure quality index is the first principal component of two variables: roads paved in percent of total roads and electric power that is not lost in transmission and distribution in percent of total output.[11]

$$Quantity\ index = 0.6377*Communication + 0.6336*Electricity + 0.4381*Roaddensity$$

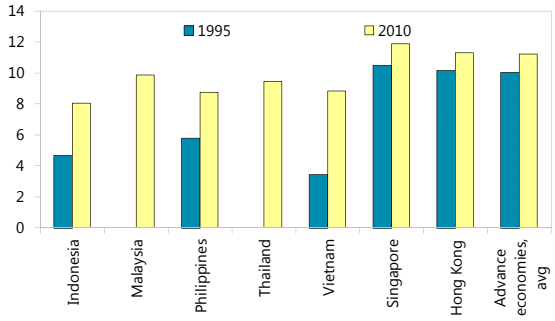
$$Quality\ index = 0.7071*Pavedroads + 0.7071*Powerdistribution$$

The quantitative indices confirm the ASEAN-5's varying infrastructure gaps described above. Among the five countries, Malaysia and Thailand have better infrastructure, both quantity and quality, than the others. Despite significant improvement in infrastructure quantity since 1995, the ASEAN-5's average infrastructure indices (both quantity and quality) are still well below those of Singapore and advanced economies. In particular, within emerging market countries, Indonesia has among the lowest infrastructure quantity indices and the Philippines has among the worst infrastructure quality indices.

[10] See appendix 1 for the full list of variables along with their definitions. The eigenvectors for the infrastructure quantity index are as follows: 0.6377 for communication, 0.4381 for road density, and 0.6336 for electricity production per capita. Eigenvectors of infrastructure quality variables are 0.7071.

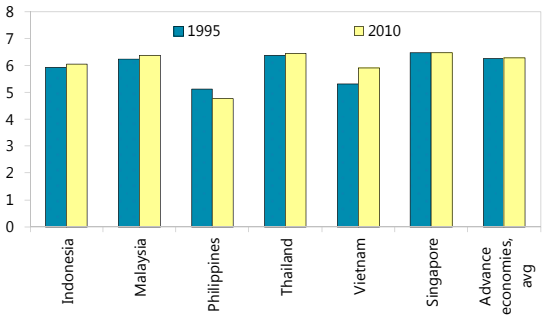
[11] Calderon and Serven (2008) included waiting time for the installation of main telephone lines in the calculation of infrastructure quality index. Due to lack of data, this variable was excluded from our estimates.

Infrastructure Quantity Index 1/



Source: IMF Staff estimates.
1/ A higher index indicates better infrastructure quantity.

Infrastructure Quality Index 1/



Source: IMF Staff estimates.
1/ A higher index indicates better infrastructure quality.

We use regression analysis covering 76 advanced and emerging market economies during the period of 1980-2010 to examine the impact of infrastructure and investment on income distribution. The regressions also include a set of standard control variables for income distribution: inflation, openness, education level, domestic credit in percent of GDP, PPP real GDP per capita and its square. It should be emphasized that our analysis is subject to data limitations, particularly regarding the measurement of income distribution and infrastructure. In light of data issues in any cross-country analysis of inequality, our results should be read with some caution. Given the focus on long-run relationships and following Calderon and Serven (2004 and 2008), our regressions use non-overlapping 5-year averages.

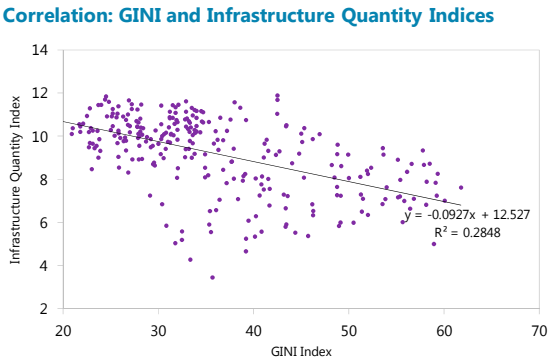
The model is estimated using simple pooled OLS with heteroscedasticity-consistent standard errors. Following Lall et al (2007), all variables in the regression are de-meaned using country specific means in order to focus on within-country changes instead of cross-country level differences, as Gini index data are not entirely comparable across countries. This is equivalent to a panel regression with fixed country effects. Time dummies are added to capture common global shocks. Various robustness tests are performed (Appendix III), including post estimation tests for model specification errors using the link test and the Ramsey regression specification-error test.

Infrastructure and income distribution may have two-way causality. Income inequality could prevent the poor from accessing infrastructure services, while at the same time inadequate infrastructure may worsen income inequality. To overcome this endogeniety problem, both infrastructure indices enter the regressions with one lag.[12]

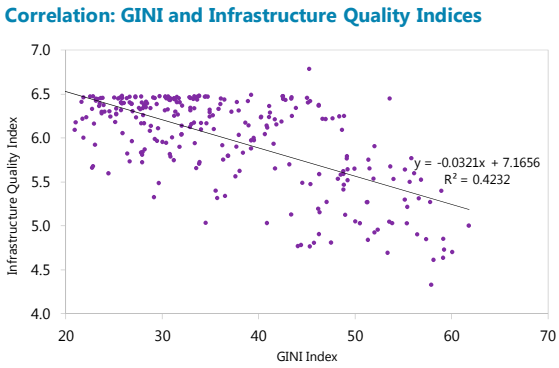
Infrastructure indices are found to reduce income inequality. Table 1 summarizes regression results for eight different models using the log of the de-meaned Gini index as the dependent variable. The first two columns include separately the infrastructure quantity and quality indices constructed above in the regressions and the third column include the two indices together. The coefficients of both infrastructure indices are negative and statistically significant in all regressions. The result that the two indices' coefficients remain similar in all

[12] Another interpretation of the regressions could be that it takes time for infrastructure improvements to translate into better –than-average increase in income of the poorer part of population.

three regressions suggests that they largely capture different aspects of infrastructure development. Simple correlations presented in the two figures below suggest that infrastructure quality and quantity are inversely related with income inequality.



Source: IMF staff estimates.

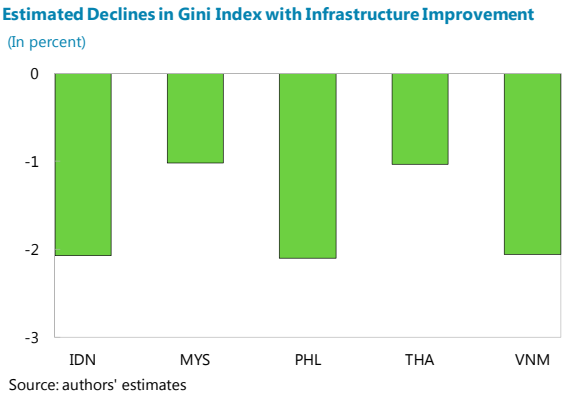


Source: IMF staff estimates.

Another way to measure infrastructure is through investment, as infrastructure development tends to be capital intensive. In the absence of cross-country data on infrastructure spending, we use total investment in percent of GDP as a proxy. Columns 4-6 in Table 1 replace the infrastructure indices with total investment, private investment, and public investment (all in percent of GDP), respectively. Investment variables also enter the regressions with one lag, as a simple way to control for potential endogeniety problem.

None of the investment variables are found to have statistically significant effects on income distribution, although their coefficients are negative. This is in contrast with our earlier result that better infrastructure, both in terms of quality and quantity, improves income distribution. One explanation could be that total investment is not a good proxy for infrastructure spending. Another explanation, which is perhaps more plausible, is that investment may not be a good proxy for infrastructure development due to spending inefficiency. In other words, the link between investment and accumulation of infrastructure assets is not necessarily strong because spending has to be mediated through institutions and governance, which are often subject to abuse (Agenor 2010). Indeed, Tanzi and Davoodi (1997) and Keefer and Knack (2007) found that weaker governance is associated with higher investment to GDP ratios. Serven (2010) also found that weaker governance and institutions drive a wedge between investment spending and actual infrastructure development. We added the index of institutional risks in the regression as a control for spending efficiency (Columns 7 and 8 of Table 1), but the baseline results do not change much.

The above results allow us to estimate the potential positive impact of infrastructure improvement (both quantity and quality) on income equality. Infrastructure gaps in Vietnam, the Philippines, and Indonesia are relatively high. Catching up to the 2010 average levels of infrastructure quantity and quality indices in advanced economies is estimated to reduce the Gini index by about 2 percentage points in those three countries (based on the model specification of Column 3 of Table 1). Reflecting its relatively good infrastructure, the



estimated decline in the Gini index of Malaysia is the smallest among ASEAN5, at 1 percentage point.

While our paper updates the work of Calderon and Serven, there are some key differences. First, we use a different and simpler estimation method (pooled OLS with fixed country effects and lagged variables), while Calderon and Serven relied on the system generalized method of moments (GMM). Second, our regression results suggest that the infrastructure quality and quantity indices may capture different aspects of infrastructure development and that both matter for income distribution. In comparison, Calderon and Serven suggested that the two indices are perhaps substitutes for each other. Finally, in addition to infrastructure indices, we also analyzed the empirical impact of investment on income equality and controlled for institutional risks.

The effects of other regressors on the Gini index are broadly in line with existing literature.

- Per capita GDP has a significant positive coefficient, while the square of per capita GDP has a significant negative coefficient. This result is indicative of the Kuznets hypothesis, which proposed that inequality may rise with the initial increase in per capita income but will decline subsequently. Calderon and Serven found a similar result.

- The coefficients of education related variables (education spending in percent of GDP and workforce with secondary education in percent of total) are negative and statistically significant, suggesting that greater access to education reduces income inequality by allowing more people to be involved in high-skill economic activities.

- Private credit in percent of GDP is found to have a significant negative effect on income distribution. This result is similar to that of Lall et al (2008). It may be counter-intuitive, given the common belief that financial development can improve income distribution by increasing the poor's access to capital. The result suggests that the effect of financial development on income distribution may depend on the quality of institutions and regulations. In the context of weak institutions and governance as well as distorted incentives, the benefits of financial deepening may accrue disproportionately to the rich and thereby exacerbate inequality.

- The higher the share of employment in industry, the more equal is the income distribution. This likely reflects the fact that industry employment raises income of lower-earning groups. Policies encouraging formal sector employment and expansion

of the industry sector to low-income regions will likely provide more inclusive employment opportunities.

- Finally, openness – as measured by the ratio of exports and imports to GDP – tends to make income distribution more unequal, as found by Barro (2000) and Calderon and Serven (2004 and 2008).

Table 1. Determinants of the Gini Coefficient 1/

(Dependent variable: natural logarithm of Gini)

	1	2	3	4	5	6	7	8
constant	11.48 ***	10.07 ***	9.51 ***	-6.12 ***	13.08 ***	13.30 ***	11.89 ***	14.36 ***
	(5.22)	(4.78)	(4.07)	(-3.37)	(6.39)	(6.62)	(5.20)	(6.37)
Inflation	0.07 *	0.05 *	0.04	0.10	0.10 **	0.09 **	0.10 ***	0.09 **
	(1.81)	(1.74)	(0.92)	(2.98)	(2.30)	(2.24)	(2.81)	(2.12)
Infrastructure quantity (lag 1)	-0.20 ***		-0.1767 ***					
	(-6.80)		(-6.82)					
Infrastructure quality (lag 1)		-0.22 ***	-0.19 ***					
		(-6.16)	(-4.56)					
Investment-to-GDP ratio (lag 1)				-0.14			-0.11	
				(-1.34)			(-1.06)	
Private investment-to-GDP ratio (lag 1)					-0.09			
					(-1.06)			
Public investment-to-GDP ratio (lag 1)						-0.03		-0.03
						(-0.80)		(-0.85)
Credit-to-GDP ratio	0.08 ***	0.09 ***	0.09 ***	0.07 **	0.02	0.01	0.06 *	0.01
	(2.68)	(2.73)	(2.66)	(2.05)	(0.42)	(0.22)	(1.68)	(0.25)
Employment share in industry (lag 1)	-0.19 **	-0.16	-0.11	-0.19 **	-0.18 *	-0.17 *	-0.26 **	-0.22 *
	(-2.35)	(-1.62)	(-1.06)	(-2.29)	(-1.75)	(-1.67)	(-2.42)	(-1.90)
PPP real GDP per capita	2.73 ***	2.06 ***	2.29 ***	2.34 ***	2.73 ***	2.77 ***	2.41 ***	2.89 ***
	(5.92)	(4.55)	(4.74)	(5.47)	(6.31)	(6.57)	(5.50)	(6.84)
PPP real GDP per capita squared	-0.01 ***	-0.01 ***	-0.01 ***	-0.13 ***	-0.01 ***	-0.01 ***	-0.01 ***	-0.01 ***
	(-5.35)	(-4.80)	(-4.18)	(-5.77)	(-6.37)	(-6.60)	(-5.85)	(-6.89)
Education spending in percent of GDP (lag 1)	-0.08	-0.11 **	-0.10 *	-0.08 **	-0.07	-0.05	-0.08	-0.06
	(-1.40)	(-2.07)	(-1.86)	(-1.34)	(-1.18)	(-0.86)	(-1.43)	(-0.93)
Openness	0.05	0.08 *	0.13 ***	0.01	0.03	0.03	0.02	0.03
	(0.97)	(1.87)	(2.61)	(0.27)	(0.60)	(0.51)	(0.41)	(0.67)
Institutional risks							-0.04	-0.14
							(-0.18)	(-0.63)
Observations	128	126	111	149	107	106	147	105
Adjusted R-squared	0.61	0.60	0.70	0.48	0.49	0.48	0.49	0.49

Source: IMF staff estimates.

1/ An * indicates significance at 10%, ** significant at 5%, and *** at 1%. t statistics are in parentheses. All explanatory variables are in natural logarithm. The equations are estimated by OLS with variables in both left and right-hand side variables de-meaned using country-specific means (equivalent to a panel estimation with country fixed effects, while also controlling for variability in GINI calculation methodologies across countries) . Underlying data are from World Bank: World Development Indicators and PovCal databases, IMF: World Economic Outlook and International Financial Statistics, and Penn World Table 7.0.

IV. CONCLUSIONS

This paper finds that better infrastructure, both in quantity and quality, improves income distribution. This result, together with the proven role of infrastructure in enhancing productivity and growth, suggests that infrastructure development can have double effects on poverty reduction and inclusive growth. For the ASEAN-5 countries, removing infrastructure gaps would not only raise potential growth but also spread the benefits of growth more evenly.

We do not find that investment promotes income equality and further analysis is warranted. This result could indicate a likely weak link between spending and buildup of infrastructure assets, consistent with the existing literature. If not supported by enhancement in efficiency and institutions, a big push to infrastructure investment may result in large waste yet little impact on equitable growth. Reforms streamlining procurement and improving coordination among institutions could strengthen institutional frameworks, thus improving the productivity of infrastructure investment.

This paper also points to other public policies that can help income distribution. Education spending to enhance human capital could increase the earning power of lower-income groups disproportionately more. Improving formal sector employment opportunities that facilitate the low-income groups' move to higher-earning jobs will also contribute to more equal income distribution. While financial development promotes growth, it may hurt income equality if the benefits of deepening accrue disproportionately to the rich. Policymakers should be conscious of the need to improve institutions and broaden the poor's access to finance.

Different types of infrastructure may have differing impacts on inequality. An area for future research will be to understand how various types of infrastructure, for example roads vs. broadband connection, may affect inequality and growth in a different way.

APPENDIX I: DESCRIPTION OF DATA

- **Gini index**: From the World Bank's World Development Indicators (WDI) database, and is based on nominal per capita income averages and distributions estimated from household survey data. Missing years are further gap-filled with data from various sources including Povcal, LIS, and OECD databases. Natural logarithm of the variable is used for the regressions.

- **Infrastructure quantity**: Authors' calculations based on the first principal component of: total telephone lines, cell subscriptions, and internet users per 100 people; electricity production per capita (in millions of KWh); and road density (km of road per 100 sq. km of land area). The underlying data are obtained from the WDI.

- **Infrastructure quality**: Authors' calculations based on the first principal component of: roads paved in percent of total roads and electric power that is not lost in transmission and distribution in percent of total output. The underlying data are obtained from the WDI.

- **Inflation**: Year-on-year growth of consumer price index, obtained from the IMF's World Economic Outlook database. Natural logarithm of inflation rate+100 are used for the regressions.

- **Investment-to-GDP**: Gross fixed capital formation in percent of GDP, obtained from the World Economic Outlook database. Natural logarithm of investment in percent of GDP is used in the regressions.

- **Private investment-to-GDP**: Gross private fixed capital formation divided by GDP. Both series are obtained separately from the World Economic Outlook database. Natural logarithm of investment in percent of GDP is used in the regressions.

- **Public investment-to-GDP**: Gross public fixed capital formation divided by GDP. Both series are obtained separately from the World Economic Outlook database. Natural logarithm of investment in percent of GDP is used in the regressions.

- **Credit-to-GDP**: Claims on private sector, obtained mainly from the IMF's International Financial Statistics database, and gap-filled with data from the IMF's Money and Banking database (MBRF2). This variable is divided by the GDP, which is obtained from the World Economic Outlook database to compile the credit-to-GDP ratio. Natural logarithm of credit-to-GDP is used in the regressions.

- **Employment share in industry**: Obtained from the World Development Indicators (WDI) database, which calculates employment in the industry sector, in percent of total employment. Natural logarithm of the variable is used in the regressions.

- **PPP real GDP per capita**: The underlying data for PPP adjusted real GDP per capita are obtained from the Penn World database. Natural logarithm of the variable is used in the regressions.

- **Education spending in percent of GDP**: Public spending on education in percent of GDP, obtained from the World Development Indicators (WDI) database. Public expenditure on education in WDI consists of current and capital expenditure on education, which includes government spending on educational institutions (both public and private), education administration as well as subsidies for private entities (students/households and other privates entities).

- **Openness**: Estimated as the sum of exports and imports in percent of GDP. The underlying data are obtained from the World Economic Outlook database. Natural logarithm of the openness variable is used in the regressions.

- **Institutional risks**: Institutional risk ratings for all countries in the sample are obtained from the International Country Risk Guide (ICRG) database of the PRS Group. The PRG Group calculates the overall index by using all 17 risk components, 12 with an 18-month forecast horizon and five with a five-year forecast horizon. A higher score indicates a lower risk environment.

APPENDIX II: COUNTRY COVERAGE

Industrial countries (24): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States

Emerging markets (52): Albania, Algeria, Argentina, Armenia, Belarus, Bosnia & Herzegovina, Brazil, Bulgaria, Chile, China, Costa Rica, Colombia, Croatia, Czech Republic, Dominican Republic, Ecuador, Estonia, El Salvador, Georgia, Guatemala, Hong Kong, Hungary, Indonesia, India, Jamaica, Jordan, Korea, Latvia, Lebanon, Lithuania, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Romania, Russia, Sri Lanka, Serbia, Singapore, South Africa, Taiwan, Thailand, Tunisia, Turkey, Ukraine, Uruguay, Venezuela, Vietnam

APPENDIX III: ADDITIONAL ESTIMATIONS

Our estimation results are checked for robustness using several approaches**.** First, we separately performed fixed country effects and least-square estimations using variables that are not de-meaned (Table 2). In all models, infrastructure quantity and quality indices remain statistically significant with negative coefficients. We also ran robustness tests by dropping one variable at a time and the results remain broadly unchanged. Furthermore, we replaced the dependant variable, the Gini index, with per capita income share held by the lowest 20 percent. Our results confirm that an improvement in infrastructure quality and quantity would increase the income share held by the poor.

Table 2. Determinants of the Gini Coefficient 1/

(Dependent variable: natural logarithm of Gini)

	1	2	3	4	5	6	7	8	9 (FE)
constant	-8.48 ***	-4.28 **	-5.81 ***	-6.12 ***	-6.25 ***	-8.19 ***	-8.52 ***	-8.43 ***	1.41
	(-4.22)	(-2.19)	(-2.76)	(-3.37)	(-3.35)	(-4.51)	(-4.99)	(-4.74)	(0.41)
Inflation	0.07 *	0.05 *	0.04	0.10 ***	0.10 ***	0.10 **	0.09 **	0.09 **	0.02
	(1.81)	(1.74)	(0.92)	(2.98)	(2.81)	(2.30)	(2.24)	(2.12)	(0.59)
Infrastructure quantity (lag 1)	-0.20 ***		-0.1767 ***						-0.11***
	(-6.80)		(-6.82)						(-4.04)
Infrastructure quality (lag 1)		-0.22 ***	-0.19 ***						-0.16***
		(-6.16)	(-4.56)						(-2.74)
Investment-to-GDP ratio (lag 1)				-0.14	-0.11				
				(-1.34)	(-1.06)				
Private investment-to-GDP ratio (lag 1)						-0.09			
						(-1.06)			
Public investment-to-GDP ratio (lag 1)							-0.03	-0.03	
							(-0.80)	(-0.85)	
Credit-to-GDP ratio	0.08 ***	0.09 ***	0.09 ***	0.07 **	0.06 *	0.02	0.01	0.01	0.01
	(2.68)	(2.73)	(2.66)	(2.05)	(1.68)	(0.42)	(0.22)	(0.25)	(0.40)
Employment share in industry (lag 1)	-0.19 **	-0.16	-0.11	-0.19 **	-0.26 **	-0.18 *	-0.17 *	-0.22 *	0.06
	(-2.35)	(-1.62)	(-1.06)	(-2.29)	(-2.42)	(-1.75)	(-1.67)	(-1.90)	(0.70)
PPP real GDP per capita	2.73 ***	2.06 ***	2.29 ***	2.34 ***	2.41 ***	2.73 ***	2.77 ***	2.89 ***	0.69
	(5.92)	(4.55)	(4.74)	(5.47)	(5.50)	(6.31)	(6.57)	(6.84)	(0.94)
PPP real GDP per capita squared	-0.14 ***	-0.12 ***	-0.11 ***	-0.13 ***	-0.14 ***	-0.15 ***	-0.15 ***	-0.16 ***	-0.04
	(-5.35)	(-4.80)	(-4.18)	(-5.77)	(-5.85)	(-6.37)	(-6.60)	(-6.89)	(-0.92)
Education spending in percent of GDP (lag 1)	-0.08	-0.11 **	-0.10 *	-0.08	-0.08	-0.07 *	-0.05	-0.06 *	-0.03
	(-1.40)	(-2.07)	(-1.86)	(-1.34)	(-1.43)	(-1.18)	(-0.86)	(-0.93)	(-0.61)
Openness	0.05	0.08 *	0.13 ***	0.01	0.02	0.03	0.03	0.03	0.07
	(0.97)	(1.87)	(2.61)	(0.27)	(0.41)	(0.60)	(0.51)	(0.67)	(1.13)
Institutional risks					-0.04			-0.14	
					(-0.18)			(-0.63)	
Observations	128	126	111	149	147	107	106	105	123
Adjusted R-squared	0.61	0.60	0.70	0.48	0.49	0.49	0.48	0.49	0.62

Source: IMF staff estimates.

1/ An * indicates significance at 10%, ** significant at 5%, and *** at 1%. t statistics are in parentheses. All explanatory variables are in natural logarithm. The equations are estimated by OLS. Underlying data are from World Bank: World Development Indicators and PovCal databases, IMF: World Economic Outlook and International Financial Statistics, and Penn World Table 7.0.

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