SUMMARY OF ESTIMATE OF INFRASTRUCTURE DEMAND ON SOCIAL and FLOOD CONTROL INFRASTRUCTURE

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Infrastructure demand uncovered by current estimate

The acceleration of economic growth in emerging countries has led to the rapid increase in demand for infrastructure in those countries. Asian countries are expected to continue to contribute more than 60% of global growth over the coming years, so that infrastructure demand in Asia will continue to be extremely strong. ADB (2017) shows that between 2016 and 2030, infrastructure demand will amount to 22.6 trillion USD for the 45 countries in Asia, or 26 trillion USD if climate change mitigation and adaptation is included. However, the financial resources needed to materialize the required infrastructure development are insufficient in many Asian countries.

Estimations of infrastructure demand have been conducted since early 2000. According to the current stylized model, which ADB (2017) is also applying, infrastructure demand depends on income growth, industrialization, and urbanization.[1] Therefore, the pace of the increase of

[1] The most frequently used model is developed by Fay and Yepes(2003), where the equation is as follows:

$$I_{i,t} = \alpha_0 + \alpha_1 I_{i,t-1} + \alpha_2 y_{i,t} + \alpha_3 A_{i,t} + \alpha_4 M_{i,t} + \alpha_5 D_i + \alpha_6 D_t + \epsilon_{i,t}$$

($I_{i,t}$ denotes infrastructure stock in Country i and Year t, y for per capita income. A for the share of agriculture in GDP, M for the share of manufacturing in GDP, D_i for country's fixed effect, D_t for time dummy, $\varepsilon$for error term)

Estimate is also made to include urbanization ratio and population density as explanatory variables. Apart from new construction demand, maintenance spending is added by multiplying infrastructure stock by certain percentage such as 2% for power, road and railway, 3% for water and 8% for telecommunication. There are other methods of infrastructure demand estimate, such as bottom-up demand is accelerating if a country experiences both high growth and a rapid transformation of economic structure. This is one of the important facts behind the increasing infrastructure demand in Asia, as rapid urbanization and industrialization is currently occurring.

Infrastructure demand estimates usually only cover economic infrastructure such as power, transportation, telecommunication, and water. However, the infrastructure demand in other sectors is also substantial. Other sectors include education and culture, disaster prevention, and agriculture and fisheries. According to Cabinet Office statistics from 2012, these sectors represent a more than 40% share of public capital stock[2] in Japan. In most cases when infrastructure issues are discussed, social infrastructure such as education and health facilities is not a part of the discussions. However, it cannot be ignored. Moreover the role of human capital is increasingly important for sustaining economic growth in emerging countries. Needless to say, human capital is the most important engine for long term growth and is integral to the attainment of the Sustainable Development Goals (SDGs). In Asia, where many countries have entered into the middle income stage, human resource development is considered as the key to overcoming the middle income trap.

Asian countries suffer the greatest amount of loss and damage due to natural disasters in the world. Once a disaster occurs, the loss and damages are huge not only because of the value of lost assets but also due to the decrease in production in some years as a result of loss in production capacity. The effects of this loss remain until production capacity returns to pre-disaster levels. Human loss as the result of these disasters also leads to a decrease in production. Moreover the loss of assets among the poor of the population, who usually have quite limited savings, may lead to decreased spending on education for their children; this drop in spending on education may then have a negative effect on potential growth. For this reason, preventive investment against disaster is essential for development. This research targets infrastructure for flood control as it is by far the largest of all disaster-related infrastructure.

Currently demand for infrastructure has only been estimated for the economic sectors, although there are some available estimates on social infrastructure in a number of countries. For instance, the Japanese Ministry of Education, Sports, Culture, Science, and Technology made public the financial demand estimates for schools for the next 30 years. However, this kind of estimate is

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individual sector analysis, or identifying the gap of infrastructure stock between the current level of target country and bench marking country such as OECD members.

2 Public capital stock does not include most of power and railway sector, or hospitals out of social infrastructure as they are basically the investment by private sectors.

not usually available in emerging countries. Accordingly, budgetary and planning authorities in those countries are unaware of the integrated figures of infrastructure demand, combining economic, social, and disaster-related infrastructure.

In addition, as ADB (2017) did not include urban railway in their estimates, we conducted an estimate of the demand on urban and high speed railway, using a bottom-up approach. We consider the bottom-up approach to be effective for estimating the demand on new fields without existing stock, such as urban or high speed railway, in most Asian countries other than China, according to the current model equation. In other words, a top-down approach may underestimate the demand on the railway sector because of the relatively expensive construction costs of those new fields.[3]

JICA's Research Approach

Based on this background, JICA started its research by estimating: 1) social infrastructure demand, the composition of schools, hospitals, housing, and government facilities; 2) flood control infrastructure; and 3) urban and high speed railway.

We needed to begin with building the methodology for estimating social and disaster-related infrastructure. We therefore decided to begin by conducting a case country exercise that included the examination of what methodology would be appropriate to adopt to all of Asia at a later stage. For social infrastructure we have undertaken individual country studies for Japan, Thailand, and Indonesia. These cover both bottom-up and top-down approaches, including building a regression equation. Japan was selected as a case study due to the availability of long term data, which included both the era of population increase and that of population decrease, and due to the availability of other estimates for comparison.

Analysis was carried out by JICA staff members, Mr. Tsuyoshi HARA and Mr. Fumiaki ISHIZUKA, and Associate Professor Yu NAMBA from Toyo University, under the useful advices and inputs of Professor Yuji NEMOTO and Professor Kazuyasu KAWASAKI from Toyo University. Dr. Kitti Limskul of Saitama University and Dr. Nattapong Puttanapong of Thammasat University, Thailand also conducted independent analysis, including new model building for Thailand, while the Institute of Economic and Social Research, Faculty of Economics, University of Indonesia led by Dr. Teguh Dartanto also contributed independent

[3] The estimation of demand on the railway sector is based on the unit cost of traditional types of railway.

analysis for Indonesia[4]. In the future, we at JICA plan to expand the demand estimate for social infrastructure to include all Asian countries, by examining the results of the three independent case studies, including the ideas on regression proposed in each.

As we did with social infrastructure, we chose Japan and the Philippines as case study countries for looking at demand estimates of infrastructure for flood control. Unlike other infrastructure sectors, disaster-related infrastructure depends largely on the geographical and climate conditions within the country. It is therefore difficult to construct one single estimate model that is generally applicable to any other countries in the world. In our view, this is why future forecasts on disaster-related infrastructure spending would be substantially based on the examination of historical disaster events. This analysis is made by Dr. Mikio ISHIWATARI, Senior Advisor of JICA and Professor Kenichi TSUKAHARA from Kyusyu University.

The demand estimate for urban and high-speed railway is made by gathering any information on future investment by country that is available from official plans or media reporting. Although we intend to cover any plans up until 2030, most of the available information relates to the first half of the entire period. Therefore, the figure for demand on urban and high speed railway that we present here is considered as the lowest boundary of investment demand for the years 2016 to 2030. This analysis is made by Mr. Hiroshi TAKEUCHI, Senior Research Fellow of JICA Research Institute. Finally, all necessary coordination and arrangements have been made by Ms. Rinko JOGO, Research Program Division, JICA Research Institute.

Result of Case Country Study

In relation to social infrastructure, Table 1 provides a summary of demand estimates for social infrastructure in Japan, Thailand, and Indonesia.

Table 1 Summary of social infrastructure demand (per GDP[1)], 2016-30)

2), 3)	Education	Health Care	Public Housing
Japan	0.52-0.70%(macro) 0.63-0.89%(micro)	0.89-1.19%(macro) 1.03-1.36%(micro)	0.19-0.44(micro)
Thailand	0.21%(macro)	0.20%(macro-benchmark)	0.53%(macro)
Indonesia	0.13-0.17%(macro)	0.29%(macro)	24.52%(macro, including

[4] The Indonesian team is composed by Dr. Teguh Dartanto, Dr. Muhammad Halley Yudhistira, Ms. Chairina Hanum Siregar, Ms. Andhika Putra Pratama and Ms. Edith Zheng Wen Yuan.

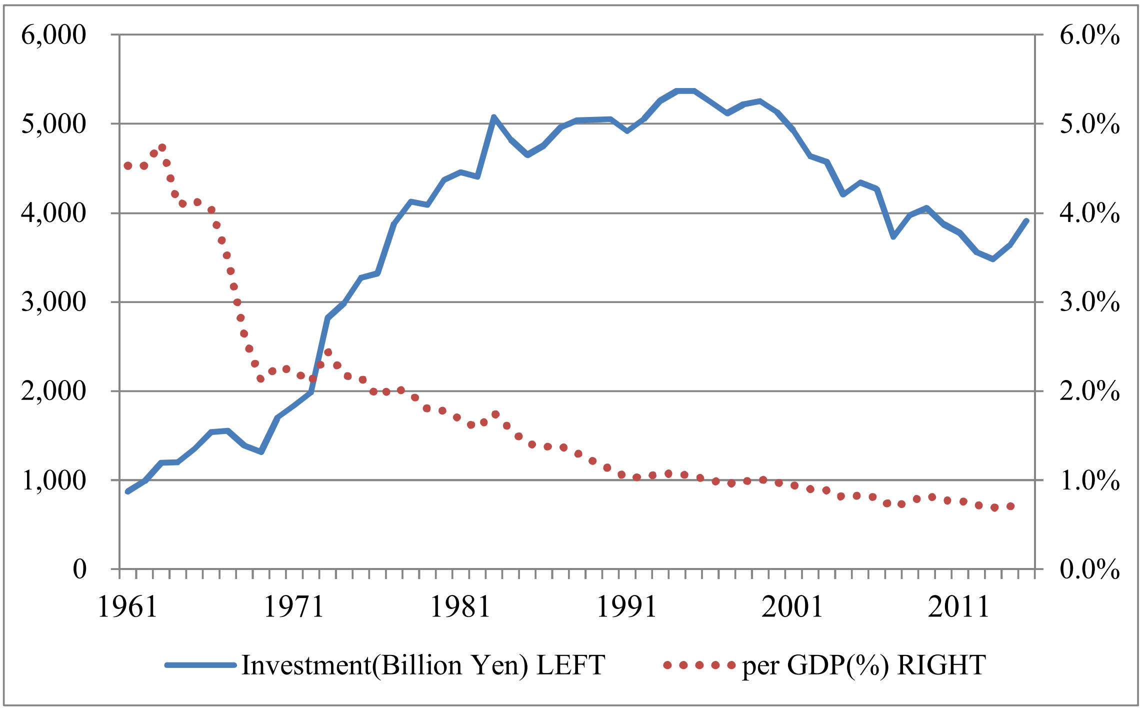
	0.02%(micro)	0.04%(micro)	private)

Note: 1) See detail in Executive Summary of case studies on how to calculate per GDP ratio, including the assumption.
2) Maintenance, rehabilitation and replacement for 3.67% of stock in Japan, 2% in Indonesia, but not included in Thailand.
3) Estimate of housing covers only pubic hosing for Japan. In case of Thailand it is a cooperation between public(NHA) and Community Organization Development Institute(CODI), while Indonesia's figure includes both public and private housing. Coverage of estimate for schools and hospitals are also different by case country. See the ANNEX.

The volume of social infrastructure investment in Japan is estimated as being as much as 0.52 to 0.89% for education, 0.89 to 1.36% for health, and 0.19 to 0.44% for social housing per GDP over the next 15 years - which is still significant. As Japan has achieved sufficient coverage of both education and health facilities and its population is expected to decrease, most of the financial demand is on maintenance, rehabilitation, and replacement. Despite this, we are unsure of the magnitude of spending on medical and educational equipment which is not a part of the estimates.

Figure 1 is the extension of the estimate model to the past. Here we see a clear trend of expenditure for schools in Japan. Financial demand on school facilities increased continuously until the early 1980s when the number of students reached its peak. Since then, as the enrollment ratio for every level of education remained unchanged, financial demand stayed at the same level until the early 2000s. It finally began to decrease as the number of students decreased. This expenditure pattern may be a useful reference for emerging countries.

Figure 1 Expenditure pattern for schools (Japan model)



Housings can be provided in several forms; public housing—rental housing for low-income household or residents with special needs; rental housing provided by corporations and residents' own housing to which government loan or subsidy may be applied. The number of public housing owned by local governments is currently 2.16 million throughout the country which is equivalent to 41.65% of households with extremely low income. As a result of the estimation with this ratio applied, Japan's public housing needs is estimated to be 31,545 billion JPY for 2016-2030 (an average expenditure per year: 2,103 billion JPY).

Thai's demand for social infrastructure investment is estimated as 0.21% for education, 0.20% for hospitals, and 0.53% for housing of the annual GDP for 2016 to 2030. The econometric estimates were applied for education and housing to build the future projection, which is a basis to estimate investment demand. The demand for hospitals was also estimated by top-down approach, however using a benchmark method where the necessary investment to reach the same "patient-bed population ratio" with South Korea is considered as the investment demand.

Indonesia's social infrastructure demand during 2016 to 2030 is estimated as 0.02 to 0.17% for education, 0.04 to 0.29% for health, and 24.52% for housing per GDP. Unlike the case in Japan, there are still large demand for new construction for education and health infrastructure in Indonesia, such as 40% and 74% respectively, according to the macro estimate, assuming that maintenance demand is equivalent with 2% of existing infrastructure stock. As housing demand estimate for the case of Indonesia includes both public and private houses, the demand scale is particularly large(24.52% of GDP), out of which 95% of the demand is for maintenance. As most of housing are the private owned, the demand for public housing would be 1.2% per GDP, assuming that public housing share is 5% of all housing. Large gaps between the the macro and micro approach such as 7 to 8 times differences are observed, which is subject to further study.

As a result of the comparative study, we found that budgetary spending on flood control is indeed on a country-by-country basis and is significantly related to the loss and damages from the worst disaster in each country's history. We therefore applied two approaches when estimating future demand, namely, 1) a simple extension of the current share of flood control investment per GDP and 2) the regression to include urbanization as an explanatory variable in addition to GDP growth and budget expenditure for flood control on previous year. Applying these ideas to the Philippines for the years 2016 to 2030, our estimate becomes 32.2 and 61.4 billion USD respectively. This scale is equivalent to between 0.45 and 0.85% of GDP through this period, where the latter is close to the highest level of spending in Japan and the Netherlands of 1% of the GDP.

In relation to the urban and high-speed railways, construction demand is estimated at 1.8 trillion USD for Asia, including China, which is a substantial amount. The scale of these investments between 2016 and 2020 - as most of the available project information relates to these years - is equivalent to 1.1% of the GDP of Thailand, 0.17% of Indonesia's GDP, and 0.26% of the GDP of the Philippines.

Findings on the key elements and methodologies, and next steps

We have produced a number of findings on the key elements as well as the research methodologies for demand estimates for social and flood control infrastructure.

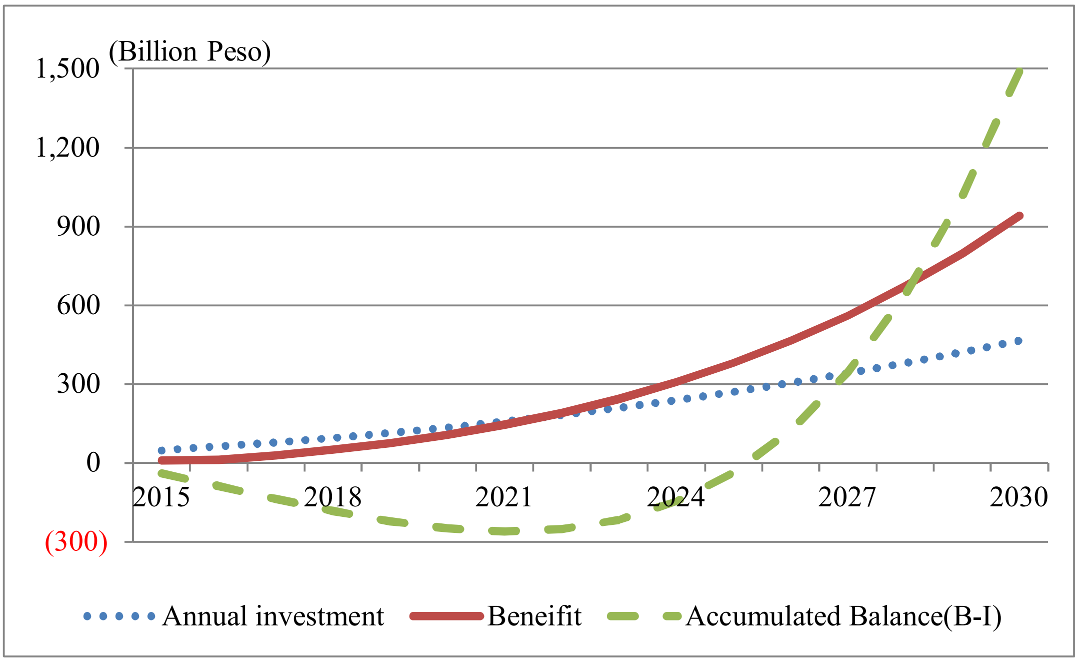
For social infrastructure three findings came to light through the case study in Japan. Firstly, the current stylized estimate model for economic infrastructure needs to be modified, as it was found to be unsuitable for social infrastructure demand estimates. Therefore, we need to adjust the equation according to the specific nature of the social infrastructure. Secondly, we found some key elements of demand estimates as a result of the bottom-up exercises. The number of beneficiaries is the most important explanatory valuable for both schools and hospitals. The enrollment ratio for higher education first increases according to economic development, then at a certain point levels off. On occasion Japan has changed its criteria for the allowable number of students in one classroom and the standard space for classroom accommodation. While the average floor area of current public housing exceeds 75 square meters, the demand for smaller public housing may be required with an increase in the ratio of single elderly households. Since it is not easy to change the size of housing during its lifetime, the planning of public housing should correspond to the increase of single-elderly households or private vacant dwellings can be used more actively instead of public housing. We need to consider the ways in which we reflect on these elements when we extend the estimate to all Asian countries. Finally, the impact of policy changes, such as the introduction of universal health coverage, has a significant effect on the demand estimate. We need to examine how we reflect on these factors when looking at future demand estimates for all of Asia.

Thai's case study is insightful for upper-middle income countries, experiencing the middle-income trap challenges and the rapid shift of demographics. The demand for social infrastructure is significant issue to raise the growth potential, such as raising skills human capital, while lowering the demand for unskilled labors. In this regard, Thai case study is particularly suggestive because the study applies the demand driven projection for enrollment ratios, in order to reflect the country's needs for human resources at different education level. Benchmark approach, which is applied for health, should be useful, particularly for upper-middle income countries such as Thailand, to estimate the necessary investment volume to reach the same standard of social services with advanced economies.

Indonesia's case must be most useful for many Asian countries where the population has been increasing, yet the absolute quantity of social infrastructure is still insufficient, particularly for health and housing. The stylized estimate model for economic infrastructure is applied in this analysis with provincial panel data, which is different from the case study for Japan where time series approach is applied. Study team for Indonesia built the panel data at provincial level, which is found useful as large regional differences, particularly for health sector, was observed in Indonesia. The differences of data sources in education such as domestic and international data did not create large differences of the result, which needs to be further examined when extending this study to all Asian countries.

Infrastructure is, in general, the physical facility or stock, benefitting the people over several decades. The nature of this is often underestimated if the benefit from the investment is invisible in the short term, in particular for disaster-related infrastructure. Figure 2 simulates the relationship between the benefits and costs of flood control investment in the Philippines. It is clear that the benefits of investment would exceed the costs in the long run; however, historically budget allocation was increased only after a large disaster hit the country. Therefore, the key consideration is how to establish the eco-system in a way that mainstreams disaster-related investment within a country's development planning and budgetary processes.

Figure 2 Benefits and costs of flood control (Philippines model)



Reference

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ANNEX: Summary of Coverage and Sources of Data on Social Infrastructure Demand Analysis

		Japan	Thailand	Indonesia
Coverage	Education	[Micro and Macro] Kindergarten Elementary Secondary University [Only for Micro] Nursery Special school for handicapped children (*Tokubetsu Shien Gakkou*) [Only for Macro] Junior college	Elementary Secondary University	Elementary Secondary
	Health	Hospital Clinic Heal Care Facility for Aged (*Kaigo Roujin Hoken Shisetsu*)	Primary Secondary Tertiary Excellent Center	Hospital PUSKESMAS1)
	Housing	Public for low income	Public(renting) Public(owning) Slam area development	Private Public
Facility Standard	Education	National	International	International
	Health	National average	National average	National average
Unit Cost of Supply	Education	[Micro] per m^2 [Macro] per facility	per facility	per facility
	Health	[Micro] per m^2 [Macro] Hospital: per m^2 Clinic: per facility	per facility	per facility
	Housing	per m^2	per facility	per facility
Operation & Maintenance (per construction cost)		3.67% 2)	Not included	2%

1) PUSKESMAS=regional community health center
2) This figure “3.67” includes replacement (depreciation rate: 1.67=100/60) and rehabilitation (60% of replacement).