

Improving Public Infrastructure in the Philippines

TAKUJI KOMATSUZAKI*

This paper explores the macroeconomic effects of improving public infrastructure in the Philippines, modeling the infrastructure scale-up plan being implemented by the current administration. After benchmarking the Philippines' level of infrastructure investment, quantity and quality of public infrastructure, and public investment efficiency relative to its neighboring countries, the analysis uses a dynamic general equilibrium model to quantitatively assess the macroeconomic implications of raising public investment expenditure with different financing schemes and different rates of public investment efficiency. Critically dependent on a model structure in which accumulation of publicly provided infrastructure raises the overall productivity of the economy, the model simulations show that (i) increasing public infrastructure investment results in sustained gains in output, (ii) the effects of improving public investment efficiency are substantial, and (iii) deficit-financed increases in public investment lead to higher borrowing costs that constrain output increases over time. These results underscore the importance of improving public investment efficiency and revenue mobilization.

Keywords: infrastructure, Philippines, public investment efficiency, revenue mobilization

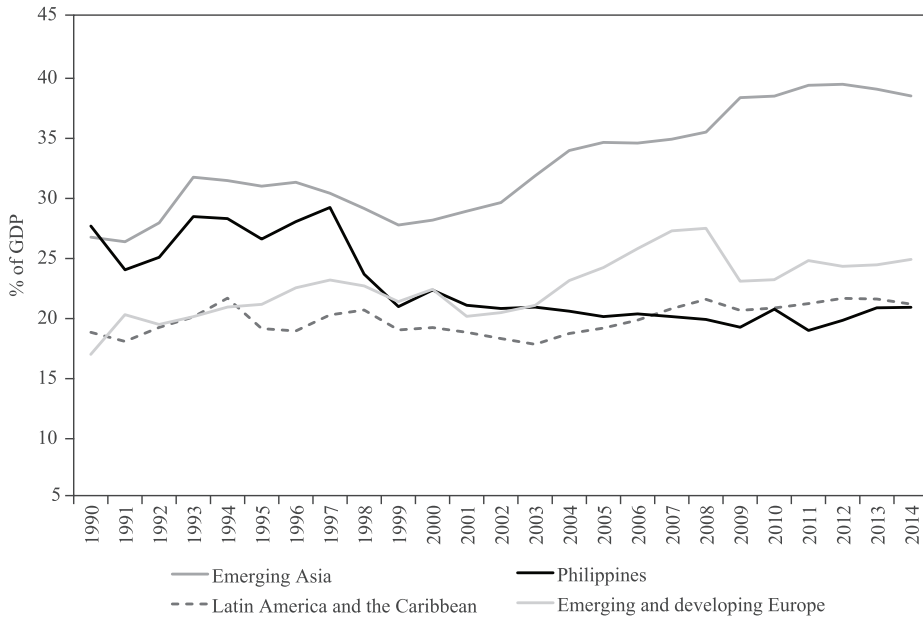
JEL codes: E22, E62, H54

I. Introduction

Upgrading public infrastructure is a major structural challenge in the Philippines. At 20.6% of gross domestic product (GDP) in 2014, the investment rate in the Philippines is well below its regional peers (Figure 1). Main impediments to private investment are inadequate infrastructure, a weak investment climate, and restrictions on foreign direct investment. In the past, a low revenue base and fiscal consolidation prevented sufficient resource allocation for public investment, while weak implementation capacity led to budget underexecution. Raising investment, particularly in infrastructure, would allow the country to reap the dividends of its

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Figure 1. Investment, Philippines



GDP = gross domestic product.

Source: International Monetary Fund, World Economic Outlook Database. <https://www.imf.org/en/Publications/SPROLLS/world-economic-outlook-databases#sort=%40imfdate%20descending> (accessed 26 February 2019).

young and growing population. To address this issue, the Philippine government embarked on an infrastructure push under the Duterte administration. It started with increasing capital expenditure by 1% of GDP in 2016 and a further 0.3% of GDP in 2017, and the government plans to increase this further over the medium term. Immediate priorities include implementing a transport system in Manila and improving airports, road connectivity, and seaports across the country.

Although there is a consensus that public infrastructure needs to be improved, the macroeconomic effects of doing so may differ depending on how this is done. First, there is a choice between deficit financing and tax financing to support an increase in government spending. In this context, the expenditure increase, so far, has mostly been financed by deficits, although the administration aims to implement a comprehensive tax reform to make the tax system simpler, fairer, and more efficient. In fact, in December 2017, the government passed the first round of tax reform, which lowered personal income taxes while raising duties on fuel, cars, coal, and sugar-sweetened drinks and also broadened the value-added tax base. The government is committed to a 3% of GDP deficit target at the national government level, which suggests that the increase in infrastructure spending in 2018 and thereafter will be financed by increasing revenue. Revenue mobilization

has always been challenging in the Philippines, however, and there is uncertainty on whether the government's plan will be legislated and implemented as envisaged. Moreover, the effect of a spending increase also depends on public investment efficiency. The same level of government spending will lead to a higher stock of public infrastructure when spending is planned, budgeted, and implemented more efficiently.

This paper explores the macroeconomic implications of improving public infrastructure by increasing public investment expenditure.¹ The analysis first benchmarks the Philippines relative to its neighbors in terms of size of infrastructure investment, quantity and quality of public infrastructure, and public investment efficiency. It confirms that infrastructure investment and the quantity and quality of public infrastructure are relatively low in the Philippines relative to other countries in the Association of Southeast Asian Nations (ASEAN), and that there is room for improvement in public investment efficiency. Subsequently, the paper simulates an increase in public investment expenditure to illustrate its macroeconomic effects using the Global Integrated Monetary and Fiscal (GIMF) model of the International Monetary Fund (IMF) and then distills policy implications from the analysis.

Model simulations suggest that improving public infrastructure would result in a sustained output increase. The baseline scenario considers the government's program, in which public investment increases by 1.2% of GDP for the first 2 years (2016–2017) and a further 2% of GDP in subsequent years. The increase in spending is financed by deficits for the first 2 years but by revenue mobilization thereafter. Assuming the same increase in public investment, two alternative scenarios are considered to illustrate the effects of alternative financing and public investment efficiency. In the first alternative scenario, no further tax reform will take place after December 2017, implying that deficit financing of infrastructure spending will increase from 2018 onward. In the second alternative scenario, public investment efficiency is higher. All scenarios exhibit sustained gains in output driven by the particular structure of the GIMF model, in which improving public infrastructure leads to gains in overall productivity of the economy, which crowds in private investment. Specifically, real GDP is higher than the steady state by 9.5% in the baseline scenario and 8.5% in the first alternative scenario after 15 years. The improvement in public investment efficiency generates substantial additional benefits. Assuming that the size of the inefficiency is halved, the increase in real GDP after 15 years is 11.7%.

Alternative schemes to finance increases in public investment generate different dynamics in public debt, consumption, and investment. While the public debt-to-GDP ratio increases by about 9 percentage points in the baseline scenario,

¹Public-private partnership (PPP) will also play an important role in improving public infrastructure in the Philippines, which has embarked on an ambitious PPP program. Moreover, the appropriate types of financing could vary depending on the types of projects. This paper focuses on government budget spending on public infrastructure.

the increase is more substantial at 24 percentage points in the first alternative scenario because it relies more on deficit financing. The larger increase in public debt increases borrowing cost and constrains investment over time in the first alternative scenario. In contrast, consumption is initially subdued in the baseline scenario because the increase in consumption tax lowers households' disposal income. While output gains are initially higher in the first alternative scenario, these gains become higher in the baseline scenario over time, with the increase in government's borrowing cost in the first alternative scenario playing a key role.

Increases in public investment expenditure also influence the current account and inflation. It initially leads to a worsening current account and also generates additional domestic demand and thus inflationary pressures. Over time, an increase in supply capacity alleviates inflationary pressures.

Sensitivity analyses exhibit the expected results and also highlight the critical role of the structure of the model in generating the baseline results. Three sensitivity analyses are performed and compared with the baseline to highlight the role of important model features: (i) altering sovereign borrowing cost parameters, (ii) altering tax instruments, and (iii) shutting down the role of public capital in enhancing overall productivity. In (i), the size of the increase in output, private investment, consumption, inflation, and the worsening current account are negatively associated with the slope of the sovereign borrowing cost vis-à-vis the public debt-to-GDP ratio. In (ii), equal distribution of revenue mobilization to corporate income tax, personal income tax, and consumption tax results in a smaller drag on consumption initially, a larger drag on investment, and lower output, relative to the baseline scenario in which a consumption tax is the sole source of revenue mobilization. In (iii), shutting down the role of public capital on overall productivity results in no medium-term effect from fiscal spending. This result highlights that sustained economic growth crucially depends on the model property that publicly provided infrastructure improves overall productivity of the economy.

With the country's low capital stock and fast-growing young population, addressing the large infrastructure gap is needed to raise potential growth and reduce poverty. This paper shows that increasing public investment spending can generate sustained output growth, and improving public investment efficiency can bring about substantial additional benefits. It also shows that deficit financing and tax financing can have different dynamics in some macroeconomic variables. Given the need to ensure debt sustainability amid the large spending needs in other priority spending areas for inclusive growth, continued efforts to mobilize revenue through a comprehensive tax reform will be critical.

II. Literature Review

This study is closest to the literature that investigates the quantitative effects of public investment increases on economic growth using dynamic general equilibrium models. While studies have applied these models to a wide variety

of countries to examine the effect of scaling up public investment (see Elekdag and Muir [2014] for application to Germany), few of them incorporate public investment efficiency outside of applying it to low-income countries.² A study by the IMF (2014) takes a first step in modeling the effect of public investment efficiency, whose structure this paper also adopts.

There is an extensive empirical literature on the effect of public investment and public infrastructure on economic growth, but the results are not conclusive. There are several issues, including data availability on infrastructure, measurement of infrastructure spending and its efficiency, and potential reverse causation in which higher economic growth generates an increase in public capital spending. Straub (2008), Romp and de Haan (2005), and Pereira and Andraz (2013) provide comprehensive reviews. Two studies by the IMF (2014 and 2015) are among the attempts to control for public investment efficiency. These studies estimate stronger growth effects of public investment in a high public investment efficiency regime, consistent with the results in this paper.

Weak public infrastructure and low public investment in the Philippines have been well documented in the literature. Historical accounts include papers by Montes (1986), Dohner and Intal (1989), Rodlauer et al. (2000), Bocchi (2008), and Warner (2014). The literature consistently documents low investment rates for the Philippines and considers this a major challenge. It also documents governance and public investment management problems. A study by the Asian Development Bank (ADB) (2017) provides the latest estimates of the status of public infrastructure and infrastructure investment needs in Asia, which this paper draws on.

III. The State of Public Infrastructure in the Philippines

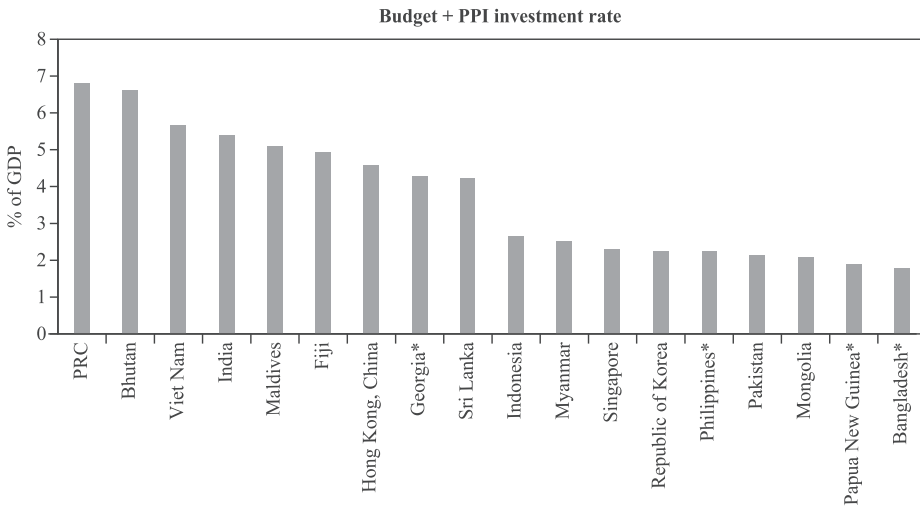
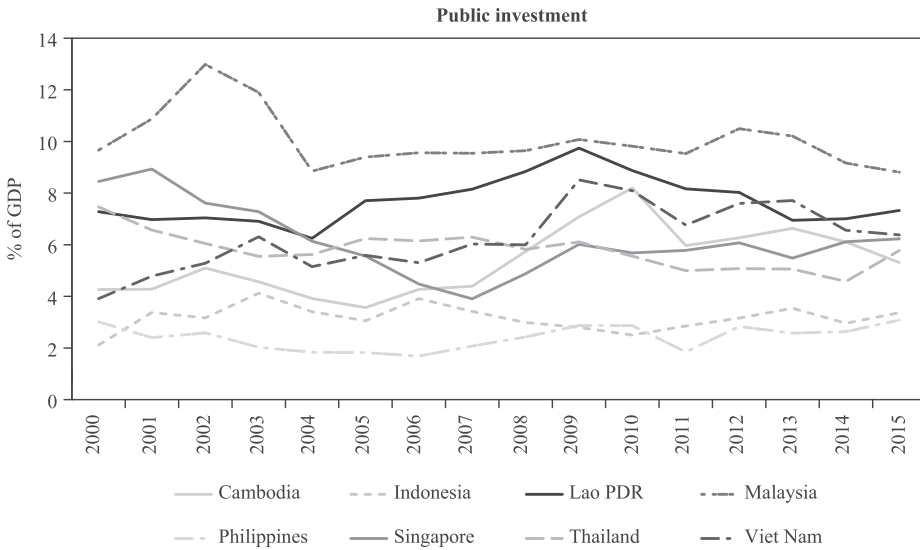
This section documents stylized facts on the status of infrastructure investment, the level of infrastructure, and public investment efficiency in the Philippines. The analysis confirms that the Philippines had low infrastructure investment in the past and that the quality and quantity of the currently available infrastructure are low relative to other ASEAN countries. The analysis also introduces a cross-country estimate of public investment efficiency, which is an important element in translating infrastructure spending into actual improvements in infrastructure.

A. Infrastructure Investment

Public investment has been consistently low in the Philippines, in fact the lowest among ASEAN countries in recent years, averaging 2.5% of GDP

²There is a series of papers, such as by Buffie et al. (2012); Melina, Yang, and Zanna (2014); Gupta, Li, and Yu (2015); and Balma and Ncube (2015), that study financing for development and scaling up public infrastructure using a model that captures the economic structure of low-income developing countries.

Figure 2. **Public Investment and Public Capital Stock, Association of Southeast Asian Nations**



GDP = gross domestic product, Lao PDR = Lao People’s Democratic Republic, PPI = private participation in infrastructure, PRC = People’s Republic of China.

Note: *Central government budget only.

Sources: International Monetary Fund. 2015. “Making Public Investment More Efficient.” IMF Policy Paper; Asian Development Bank. 2017. *Meeting Asia’s Infrastructure Needs*. Manila; and IMF staff estimates.

in 2000–2014 (Figure 2, upper panel). Public investment is an imperfect measure of infrastructure investment, however, because state-owned enterprises and the private sector also invest in infrastructure, not just the government. A study by

ADB (2017) took a careful look at the measurement of infrastructure investment in developing Asia, focusing on transportation, electricity generation capacity, and telecommunication and water infrastructure, collecting information from multiple data sources. Using its preferred measure of infrastructure investment that includes only budget spending on infrastructure and private participation in infrastructure, the Philippines' infrastructure investment is a little over 2% of GDP, 1.5 percentage points lower than the sample average (Figure 2, lower panel). This pattern is confirmed using two other measures of infrastructure investment (ADB 2017). Therefore, the analysis concludes that the Philippines' infrastructure investment has been low relative to other countries in the region.

B. Status of Infrastructure

Quantitative indicators show an uneven picture (Figure 3). Electricity generation capacity per capita is among the lowest in ASEAN. Given the continuing and prospective high economic growth in the Philippines, there is an acute need to enhance capacity. Power transmission and distribution loss is at the ASEAN average, but with room for further improvement. On the other hand, mobile cellular subscription is high at more than one per person, similar to most ASEAN countries. Access to improved water sources and sanitation facilities are both at the ASEAN averages.

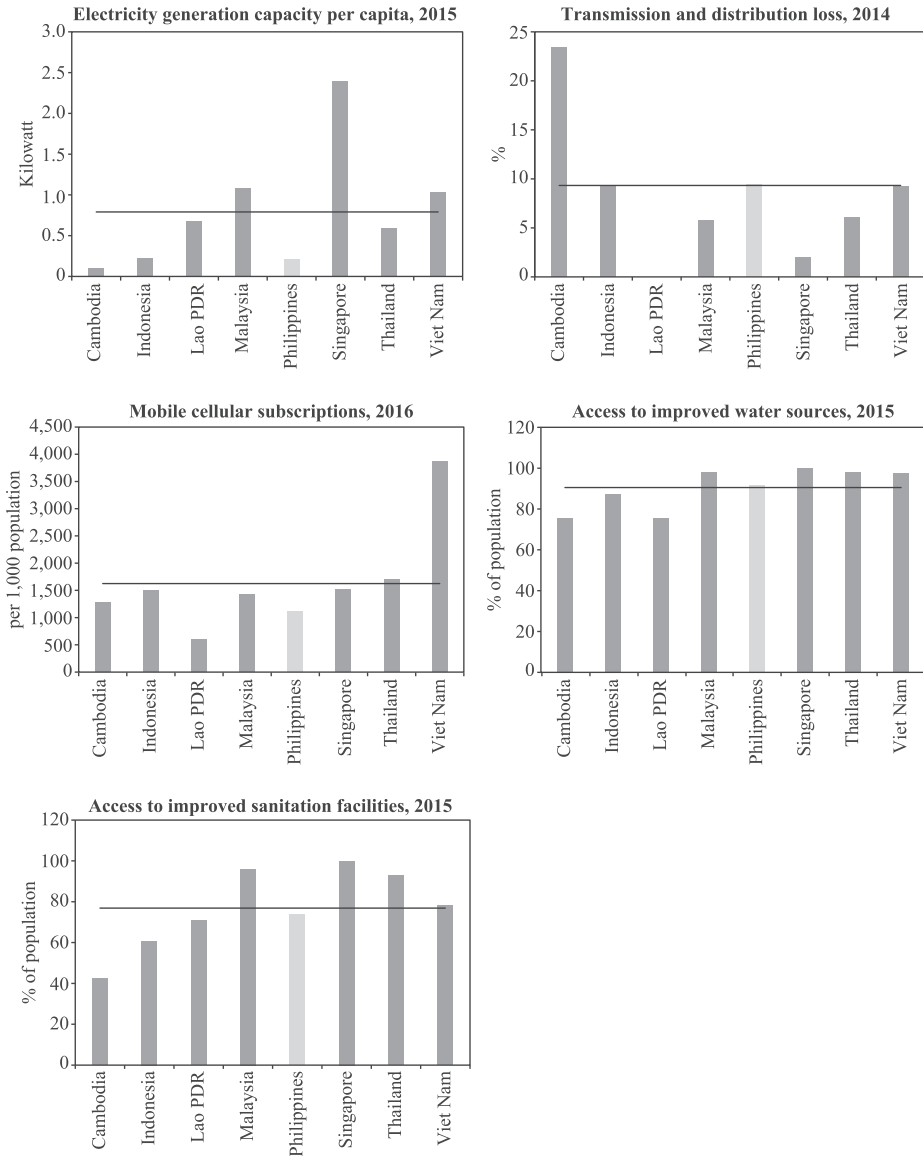
Survey-based indicators paint an unfavorable picture (Figure 4). The World Economic Forum's global competitiveness report surveys business leaders' impressions on a wide range of topics in the business environment on a scale of 1–7. The report places the Philippines among the lowest in ASEAN in key infrastructure services and substantially lower than the ASEAN average in overall infrastructure and all of its subcomponents.

In sum, most indicators of infrastructure suggest that the Philippines' infrastructure lags behind its ASEAN peers, which, given the prospects of high demand for infrastructure from economic and demographic growth, indicates that there is a need for a significant upgrade.

C. Public Investment Efficiency

An IMF study (2015) developed the public investment efficiency indicator, an outcome-based estimation of public investment efficiency (Figure 5). First, the public capital stock (input) and indicators of access to and quality of infrastructure assets (output) are documented for over 100 countries. Then the public investment efficiency frontier is estimated as the highest levels of output that can be achieved for given levels of input. Finally, an efficiency score is derived for each country as the distance from the frontier. A country's score is higher if a given level of public capital stock is associated with higher access to and quality of infrastructure assets.

Figure 3. Quality of Infrastructure

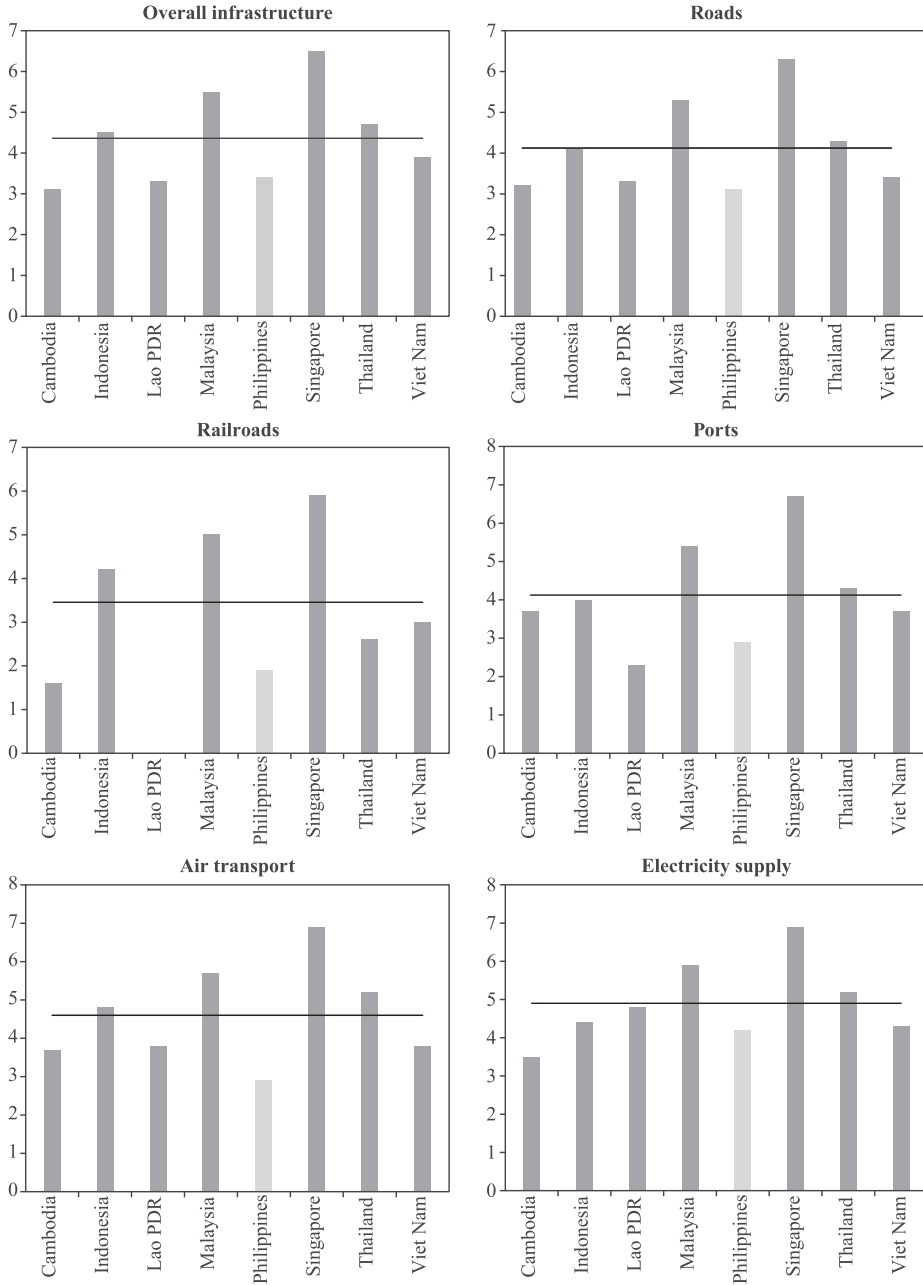


Lao PDR = Lao People’s Democratic Republic.

Note: The horizontal lines are averages.

Sources: International Energy Statistics. <https://www.iea.org/statistics/index.html>; World Bank. World Development Indicators. <https://datacatalog.worldbank.org/dataset/world-development-indicators> (both accessed 31 October 2018).

Figure 4. **Quality of Infrastructure, Association of Southeast Asian Nations**
(Scale of 1–7)

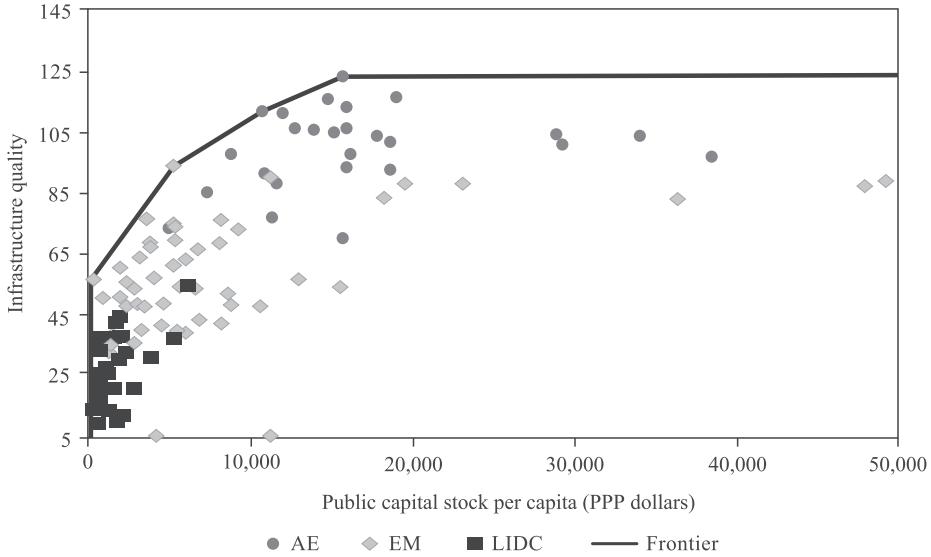


Lao PDR = Lao People’s Democratic Republic.

Note: The horizontal lines are averages.

Source: World Economic Forum. 2017. *The Global Competitiveness Report 2017–2018*. Geneva.

Figure 5. Cross-Country Comparison of Public Investment Efficiency



AE = advanced economies, EM = emerging market, LIDC = low-income developing countries, PPP = purchasing power parity.

Notes: The efficiency frontier shows the level of infrastructure quality (output) at a given capital stock per capita (input). The closer a country is to the efficiency frontier, the more efficient its public investment.

Source: International Monetary Fund. 2015. "Making Public Investment More Efficient." IMF Policy Paper.

The score is defined separately for advanced, emerging market, and low-income economies because of the large divergence in income per capita, and the relationship between input and output is likely to be nonlinear as income per capita increases. The estimation results show that the efficiency gap is around 30% on average for the full sample and the emerging market economies subsample.

IV. Global Integrated Monetary and Fiscal Simulations

A. Model and Calibration

This section simulates the macroeconomic effects of public investment expenditure using the GIMF model. The GIMF is a multiregion general equilibrium macroeconomic model developed by the IMF's Research Department. It has optimizing producers and households, frictions in the form of sticky prices and wages and real adjustment costs, a financial accelerator mechanism, monetary policy that follows inflation-forecast targeting, and fiscal policy that ensures debt sustainability. The model allows for discretionary fiscal policy in the short run, and includes a detailed description of fiscal policy that allows for the choice

of seven different fiscal policy instruments encompassing both revenue and expenditure measures. The finite lifetime of households, some of whom are liquidity constrained, implies that the model generates strong macroeconomic responses to fiscal shocks. Moreover, public investment creates public capital, which contributes to overall domestic output, as the final output uses both private and public capital as inputs. In addition to this default structure of the GIMF model, this paper introduces an endogenous change in sovereign borrowing premium as a function of public debt-to-GDP ratio in a stylized way, to take into account the macroeconomic effects of debt accumulation through borrowing costs. A three-region (Philippines, rest of emerging Asia, and rest of the world) version of the model is used, and the focus is on dynamics in the Philippines. Parameters for the Philippines are calibrated to the current state of the Philippine economy (see table on page 173). Below is a more detailed description of notable features of the model that are most relevant to this paper. Kumhof et al. (2010) and Anderson et al. (2013) elaborate further on the theoretical structure and main simulation properties of the GIMF model more generally.

1. Households

There are two types of households who receive utility from consumption and disutility from labor in a standard utility function and who maximize lifetime utility. First, there are overlapping-generation (OLG) households who make decisions on borrowing, saving, and labor supply over a 20-year planning horizon. Second, there are liquidity-constrained (LIQ) households who differ from OLG households in that they do not save and have no access to credit. The finite horizon in both households' optimization problem and the LIQ households' large propensity to consume out of income generate a strong effect for fiscal policy in the model. The relative size of LIQ households (η) is calibrated to be 50% of total households.

2. Production

Domestic manufacturers produce either tradables (Y_t^{TH}) or nontradables (Y_t^N) and solve profit maximization problems. They are monopolistically competitive in output, and price setting is subject to nominal rigidities. Manufacturers use private capital (K_t) and labor (L_t) as inputs, which capital goods producers and households provide, respectively. For firm i in sector $J = TH, N$, the production function is

$$Y_t^J(i) = \left((1 - \alpha_J)^{\frac{1}{\xi_J}} (K_t^J(i))^{\frac{\xi_J - 1}{\xi_J}} + (\alpha_J)^{\frac{1}{\xi_J}} (T_t A_t^J L_t^J(i))^{\frac{\xi_J - 1}{\xi_J}} \right)^{\frac{\xi_J}{\xi_J - 1}} \quad (1)$$

where $T_t A_t^J$ is labor-augmenting productivity comprised of trend technology growth (T_t) and sector-specific technology shock (A_t^J).

Production of private capital is standard but is subject to a financial accelerator mechanism adapted from Bernanke, Gertler, and Gilchrist (1999), which amplifies business cycle dynamics. Unions organize households' labor supply in the labor market, which generates nominal rigidity in wages.

Distributors combine output of domestically produced tradables (Y_t^{TH}) and foreign-produced tradables (Y_t^{TF}) and produce composite tradables (Y_t^T). They then combine Y_t^T and Y_t^N , aggregating them into final private goods (Y_t^A) according to the following production function:

$$Y_t^A = \left((\tilde{\alpha}_{T_t})^{\frac{1}{\xi_A}} (Y_t^T)^{\frac{\xi_A-1}{\xi_A}} + (\tilde{\alpha}_{N_t})^{\frac{1}{\xi_A}} (Y_t^N)^{\frac{\xi_A-1}{\xi_A}} \right)^{\frac{\xi_A}{\xi_A-1}} \tag{2}$$

Then Y_t^A are combined with public goods to produce the final domestic output of the country (Z_t^D):

$$Z_t^D = Y_t^A (K_t^{G1})^{\alpha_{G1}} S \tag{3}$$

where S is a technology scaling factor used to normalize steady-state technology to 1 ($(\bar{K}^{G1})^{\alpha_{G1}} S = 1$). Z_t^D is distributed to producers of domestic consumer goods and producers of domestic investment goods or exported to importers of foreign final goods. Consumer goods are consumed by households and the government, and investment goods are demanded by producers of capital goods and the government to produce private and public capital, respectively. Final goods exported are used for foreign consumption and production.

A higher K_t^{G1} increases overall productivity of the economy for a given level of Y_t^A if $\alpha_{G1} > 0$. This also leads to higher marginal productivities of capital and labor. Combining (1), (2), and (3), marginal productivities of capital and labor in sector $J = TH, N$ are $MPK_t^J = (K_t^{G1})^{\alpha_{G1}} \underbrace{\frac{\partial Y_t^A}{\partial K_t}}_{>0}$ and $MPL_t^J = (K_t^{G1})^{\alpha_{G1}} \underbrace{\frac{\partial Y_t^A}{\partial L_t}}_{>0}$,

respectively. Therefore marginal productivities increase in K_t^{G1} as long as $\alpha_{G1} > 0$, while K_t^{G1} does not affect marginal productivities if $\alpha_{G1} = 0$.

Output elasticity of public capital (α_{G1}), a key parameter, is set at 0.1, more conservative than the estimate in Bom and Ligthart (2014), where estimated elasticities of output to public capital installed by the national government are 0.122 for all public capital and 0.17 for core infrastructure capital.

Government investment spending augments the stock of publicly provided infrastructure capital per capita K_t^{G1} . Evolution of K_t^{G1} , after rescaling by growth in technology (g) and population (n), is given by³

$$K_{t+1}^{G1} (1 + g) (1 + n) = (1 - \delta_{G1}) K_t^{G1} + G_t^{inv}$$

³In the model, n and g are used to allow for trend growth in technology and population that is region specific while ensuring stationarity of the model.

Government investment spending is part of fiscal policy, which the analysis turns to in the next section.

3. Fiscal Policy

The government’s budget constraint after rescaling by growth and technology is

$$b_t + \tau_t = \frac{i_{t-1}}{\pi_t gn} b_{t-1} + p_t^G G_t + \Upsilon_t$$

where b_t is public debt, i_{t-1} is gross nominal interest rate, and

$$\tau_t = \underbrace{\tau_{L,t} w_t L_t}_{\text{labor income}} + \underbrace{\tau_{c,t} p_t^c C_t}_{\text{consumption}} + \underbrace{\tau_{ls,t} + \tau_{k,t} \sum_{j=N,T} [u_t^j r_{k,t}^j - \delta_{k_t}^j q_t^j - a(u_t^j)] \bar{K}_t^j}_{\text{return to capital}}$$

$$G_t = G_t^{cons} + G_t^{inv}$$

$$\tau_{ls,t} = \tau_{ls,t}^{OLG} + \tau_{ls,t}^{LIQ}$$

$$\Upsilon_t = \Upsilon_t^{OLG} + \Upsilon_t^{LIQ}$$

The model allows a choice of seven different revenue and expenditure policies: taxes on capital ($\tau_{k,t}$), labor ($\tau_{L,t}$), and consumption ($\tau_{c,t}$); government consumption (G_t^{cons}); government investment (G_t^{inv}); general transfers (Υ_t) or lump-sum tax ($\tau_{ls,t}$); and transfers exclusive to LIQ households (Υ_t^{LIQ}).

From the budget constraint, overall fiscal surplus (gs_t) is

$$gs_t = - \left(b_t - \frac{b_{t-1}}{\pi_t gn} \right) = \tau_t + g_t^X - p_t^G - \Upsilon_t - \frac{i_{t-1} - 1}{\pi_t gn} b_{t-1}$$

Fiscal policy ensures a nonexplosive government debt-to-GDP ratio by adjusting tax rates or by reducing expenditure so that the debt-to-GDP ratio always returns to the calibrated steady-state values in the long run. This implies that fiscal deficit can deviate temporarily, but not permanently, from the level that is consistent with the steady-state debt-to-GDP ratio. In this paper, the Philippines’ long-run overall fiscal deficit-to-GDP ratio ($-gs_t^{rat}$) is set to 2% to be consistent with recent history. Thus, the deficit level under the current administration is interpreted as a temporarily higher deficit. The steady-state long-run debt-to-GDP ratio (bs_s^{rat}) is 45%, set to be consistent with the steady-state overall fiscal deficit of 2%.

Public investment inefficiency is introduced in the model by assuming that not all public investment spending contributes to the formation of public capital. Specifically, part of the budgeted public investment (G_t^{inv}) is reclassified as public

consumption (G_t^{CONS}), which is unproductive in the model by construction.⁴ The size of the reclassification is dependent on the degree of inefficiency, which is set at 30% in the baseline, drawing on the emerging market economy average in an IMF study (2015) (see section III.C). Reflecting this assumption, steady-state government investment is assumed to be 2.3% of GDP, although officially it has been 3.3% of GDP on average since 2011 at the general government level.

4. Monetary Policy

Monetary policy follows an inflation-forecast targeting interest rate rule that responds to deviations of inflation forecasts from the target. In particular, the short-term rate is set by targeting a weighted average of current and 1-year ahead inflation, while steady-state inflation is set at 2%.

5. Risk Premium of Sovereign Debt

It is assumed that there is a premium in the government's borrowing cost that is increasing in the debt-to-GDP ratio. Following Schule (2010), it is specified as

$$\log(1 + \text{premium}_t) = \beta_1 + \beta_2 / (B_{\text{limit}} - B_t / \text{GDP}_t)^{\beta_3} + \varepsilon_t$$

The premium is set to rise by 3 basis points per increase in the debt-to-GDP ratio in the baseline, but sensitivity analyses will also be performed given the uncertainty on this calibration. Changes in the borrowing cost by the government are translated to the borrowing cost of the private sector in the GIMF model.

B. Scenarios

The baseline scenario follows the government's program in which an infrastructure scale-up of 1.2% of GDP for the first 2 years and another 2% of GDP in subsequent years takes place, financed by a deficit increase for the first 2 years but by revenue mobilization thereafter. This is based on the Duterte administration's record so far and its plan going forward, starting in 2016. Public investments in the first 2 years are actual increases, equal to 1.2% of GDP during 2016–2017 and financed by a deficit increase, according to the IMF (2018). Infrastructure increase for 2018 onward is a projection. The authorities envisage ₱8 trillion–₱9 trillion public infrastructure spending over 2017–2022.⁵ Dividing ₱8.5 trillion by the average of the 2017–2022 nominal GDP projection in the IMF (2018) results in 6.8% of GDP. This is 2% of GDP higher than the 2017 actual spending. With respect to financing, the authorities passed the first tax reform package in December 2017

⁴This specification follows a similar exercise in IMF (2014).

⁵BuildBuildBuild. Philippine Infrastructure Transparency Portal. <http://www.build.gov.ph/>.

Calibration for the Philippines

Parameters	Value	Description
$\xi_J, J = TH, N$	1	Capital–labor elasticity of substitution for domestic tradables and nontradables production; default value in GIMF
ξ_A	0.5	Tradable–nontradable elasticity of substitution; default value in GIMF
η	0.5	Share of LIQ households; set relatively high as typical in emerging markets and low-income countries
α_{G1}	0.1	Elasticity of output to public capital; more conservative than Bom and Ligthart's (2014) estimate of all public capital (0.122) and core infrastructure capital (0.17), which was used in IMF (2014)
δ_{G1}	0.04	Depreciation rate of public capital; default value in GIMF
β_1		Endogenously derived as $\beta_1 = -\frac{\beta_2}{\left(Blimit - \frac{B}{GDP}\right)^{\beta_3}}$ so that $\log(1 + premium_t) = 0$ at steady state
β_2	−0.0003	Slope of sovereign debt premium function; lower than Peiris (2015) estimate of 0.0005–0.0006 to account for recent improvements in fiscal management
β_3	−1	Curvature of sovereign debt premium function; −1 implies linearity
$Blimit$	80	Upper limit for public debt-to-GDP ratio; higher than historical maximum
\overline{bss}	45	Steady-state public debt-to-GDP ratio
\overline{gss}	−2	Steady-state overall fiscal balance-to-GDP ratio

GDP = gross domestic product, GIMF = Global Integrated Monetary and Fiscal, IMF = International Monetary Fund, LIQ = liquidity constrained.

Sources: Kumhof, Michael, Douglas Laxton, Dirk Muir, and Susanna Mursula. 2010. "The Global Integrated Monetary and Fiscal Model (GIMF)—Theoretical Structure." IMF Working Paper No. 10/34; International Monetary Fund. 2014. *World Economic Outlook, October 2014*, Chapter 3. Washington, DC; and author's calculations.

amounting to 0.5% of GDP while also planning for further tax reform to prevent the deficit from increasing further. Consumption tax is envisaged as the main source of revenue mobilization.

The first alternative scenario considers the same increase in infrastructure spending, but assumes there is no further revenue mobilization after the tax legislation passed in December 2017. Therefore, the increase in infrastructure spending is financed by an increase in overall fiscal deficit, except for the 0.5% of GDP covered by the December 2017 legislation.⁶ Expenditure reallocation is not considered as a tool to finance public investment given the small size of total government expenditure in the Philippines and the existence of other spending priorities that makes it difficult to reallocate expenditure at a large scale.

The second alternative scenario considers efficiency gains from the baseline. In this improved efficiency scenario, the size of public investment inefficiency is half the 30% inefficiency in the baseline.

⁶To ensure that all scenarios go back to the same level of debt-to-GDP ratio in the long run, the deficit-financed public investment scale-up is limited to the first 25 years. The study's comparison focuses on the periods in which the public investment scale-up is financed by the deficit in the first alternative scenario.

C. Results

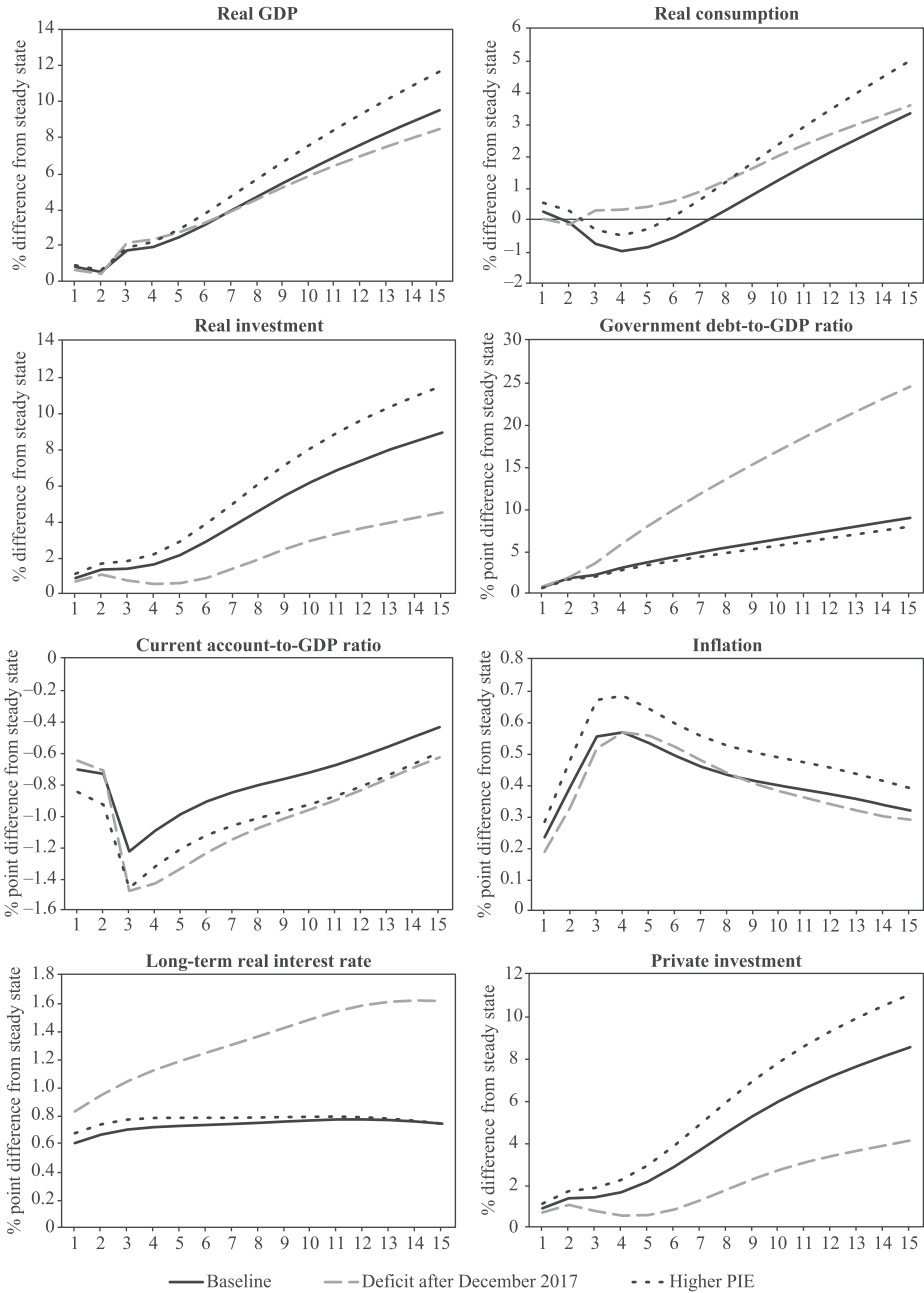
The baseline scenario leads to sustained gains in real GDP (Figure 6). Public investment increases have sustained output effects beyond the direct demand effect of the spending increase because of the productivity-enhancing impact of public infrastructure. As public capital is an input to the aggregate production function of the economy, the improved public infrastructure raises overall productivity, akin to an increase in total factor productivity from the perspective of the private sector. The resulting increase in marginal productivity of capital and labor crowd in private investment and increase demand for labor, which induce a higher consumption due to higher household income. The increase in public investment results in a 9.5% cumulative increase in real GDP relative to the steady state after 15 years.

In the first alternative scenario with no further tax reform package, the output gains are initially higher than in the baseline scenario, although the gains will become larger in the baseline over time, with the increase in the government's borrowing cost playing a key role. The baseline scenario results in smaller output gains in the short to medium term because the tax increase reduces consumption, partially offsetting the demand increase from higher public investment. Over time, however, the continuous increase in the debt-to-GDP ratio in the first alternative scenario increases domestic interest rates, with negative effects on private investment and consumption and leading to decelerating output growth.

The increasing influence of the government's borrowing cost over time can be seen by comparing the paths of long-term real interest rates, the interest rate most relevant for the investment decisions of the private sector. In the GIMF model, an increase in the government's borrowing cost due to an increase in the risk premium leads to a parallel increase in all domestic interest rates. Additionally, domestic interest rates are also affected by monetary policy. The long-term real interest rates reflect both of these factors and increase on impact for both the baseline scenario and the first alternative scenario. However, the increase is larger for the latter in anticipation of the future increase in the risk premium. The paths further diverge from each other over time, driven by the increasing risk premium in the first alternative scenario.

Improving public investment efficiency generates an additional impact. Raising public investment efficiency to about 85% increases output by 2.1 percentage points after 15 years compared with the baseline scenario. In the baseline scenario of 30% inefficiency, a 6% of GDP public investment results in a 4.2% of GDP contribution to public infrastructure. When public investment inefficiency is reduced to 15%, the same 6% of GDP public investment results in a 5.1% of GDP contribution to public infrastructure and a cumulative increase in GDP of 11.7% after 15 years. This improvement in efficiency generates balanced effects, increasing consumption and investment and decreasing the

Figure 6. Main Simulation Results



GDP = gross domestic product, PIE = public investment efficiency.

Notes: The x-axis shows the number of years since the start of the simulation. T = 1 is set to the year 2016.

Source: Author's calculations.

debt-to-GDP ratio relative to the scenarios without improvements in public investment efficiency.

Additional demand from higher public infrastructure gives rise to inflationary pressures and a positive output gap, inducing an increase in the policy interest rate. Different degrees of inflation can be explained by the different sizes of private investment crowding in and the resulting consumption increase. Over time, an increase in supply capacity alleviates the inflationary pressures and the policy rate increases are gradually reversed in all scenarios.

The current account exhibits an initial deterioration, mostly because of higher imports. Exports also decline initially due to the initial real appreciation associated with the policy interest rate increase. Subsequently, exports increase as investment stimulates production and the initial real appreciation is reversed, in line with the reversal of initial monetary tightening, which partially offsets the worsening current account. The size of the current account deficit-to-GDP ratio increase is roughly proportional to the output increase and reaches 1.2 percentage points after 3 years in the baseline scenario and 1.5 percentage points after 3 years in the two alternative scenarios.

D. Sensitivity Analysis

This subsection considers three types of sensitivity analyses: changes in the assumption on the borrowing cost premium, changes in the tax mix, and shutting down the role of public capital in enhancing overall productivity.⁷

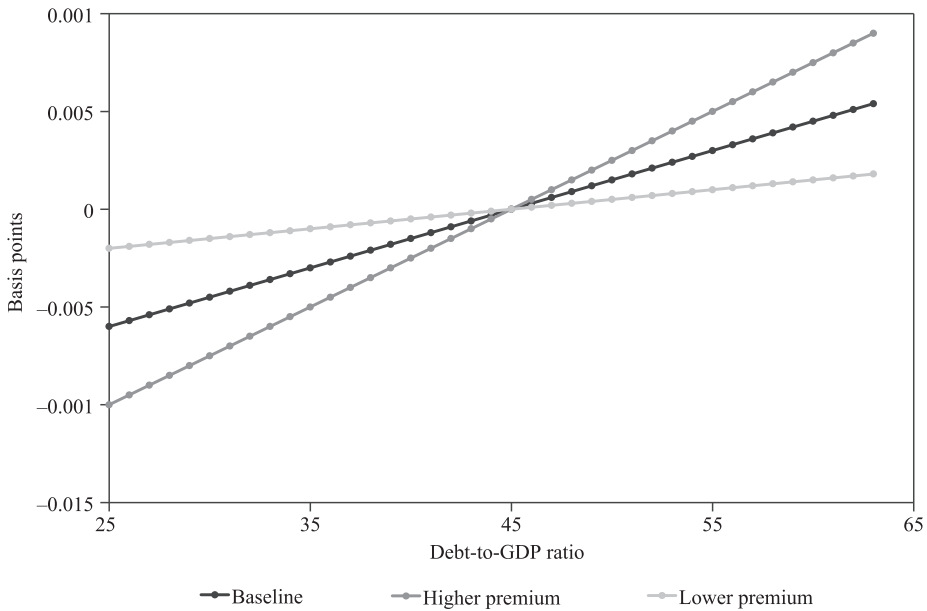
1. Alternative Borrowing Cost Premia

Given the key role of borrowing interest rates on output dynamics, two additional calibrations on the borrowing cost premium are examined. The relationship between public debt and the borrowing cost is uncertain and affected by various factors, both global and local.⁸ A higher calibration sets the premium at 5 basis points per unit increase in the debt-to-GDP ratio. This draws on Peiris (2015), who estimated the determinants of 10-year government bond yields in the Philippines, while controlling for a comprehensive list of variables, and finds that the marginal effect of a unit increase in the debt-to-GDP ratio is 5–6 basis points. The baseline in this study has adopted a lower estimate of the borrowing cost based on recent improvements in the Philippines' fiscal management, as reflected in credit rating upgrades in recent years, interpreting these improvements as structural changes. It is also possible to assume that the transformation has led to an even

⁷Simulation results are based on no improvements in public investment efficiency. Improvements in public investment efficiency would result in a parallel increase in output, investment, consumption, etc.

⁸Baldacci and Kumar (2010), and the review therein, estimate that the response of borrowing costs to changes in public debt ranges from 3 to 7 basis points per unit increase in the debt-to-GDP ratio.

Figure 7. Sovereign Risk Premia for Different Assumptions



GDP = gross domestic product.
Source: IMF staff estimates.

lower borrowing cost. This is the lower premium calibration, which assumes a 1 basis point response per unit increase in the debt-to-GDP ratio. Figure 7 shows the borrowing cost premia for the three scenarios.

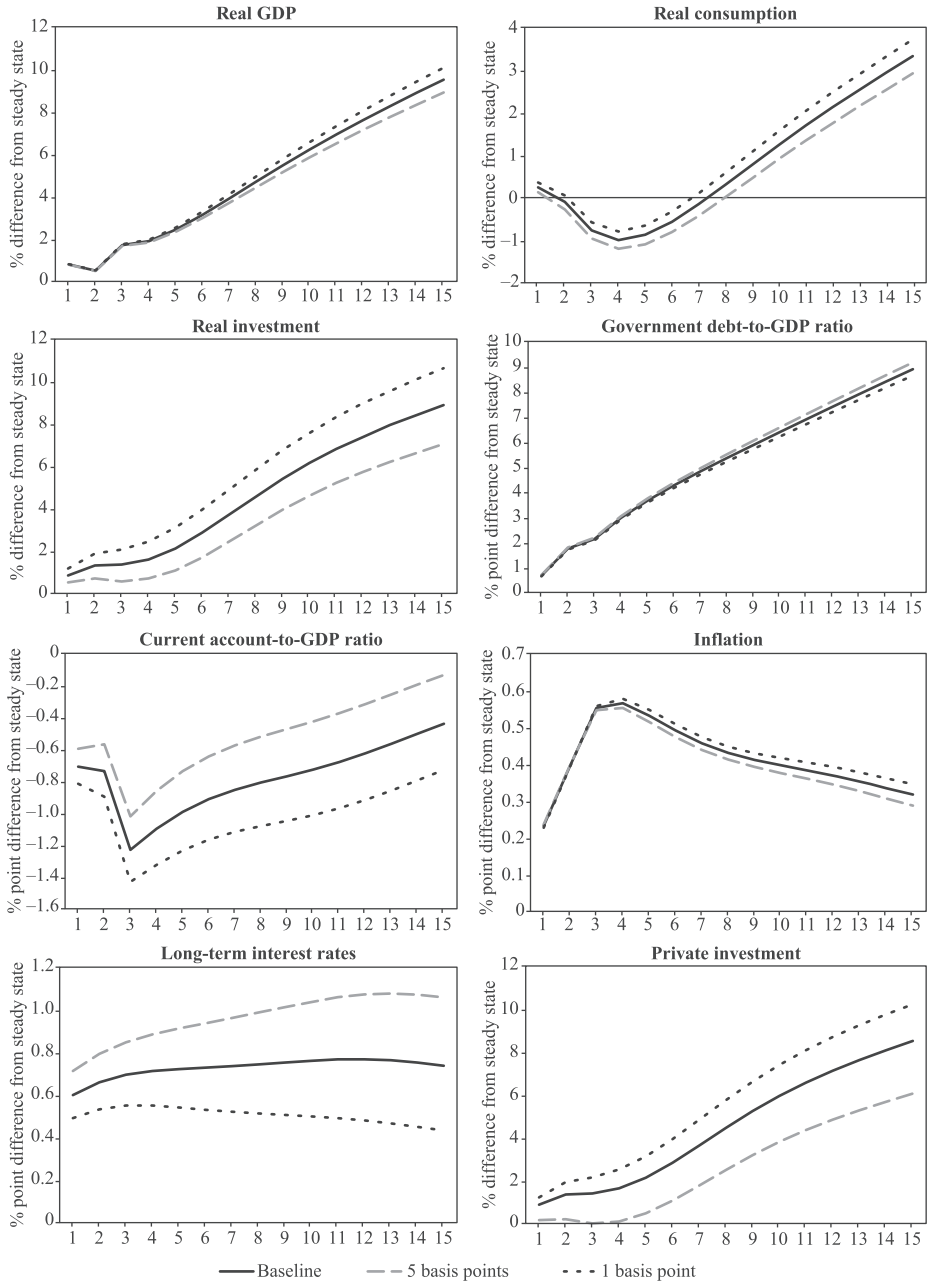
The simulations show the expected results (Figure 8). The effect on output of scaling up public investment is more subdued the higher the increase in borrowing cost. Trajectories of all the other variables change accordingly.

2. Alternative Tax Instruments

Revenue mobilization to finance public investment may require the use of multiple sources. Reliance solely on the consumption tax, assumed in the baseline scenario, implies a tax rate increase of around 2.7%. This may not be politically feasible and other revenue sources may be found. To capture this possibility, the analysis assumes that revenue mobilization is equally distributed to capital, labor, and consumption taxes in this alternative scenario.

The results show that there is less drag on consumption initially and more drag on investment (Figure 9). Output growth is lower in this alternative scenario than in the baseline. The superiority of indirect taxes on growth is a general feature of the GIMF model (Anderson et al. 2013) and is consistent with Lucas (1990) and

Figure 8. Alternative Borrowing Cost Results

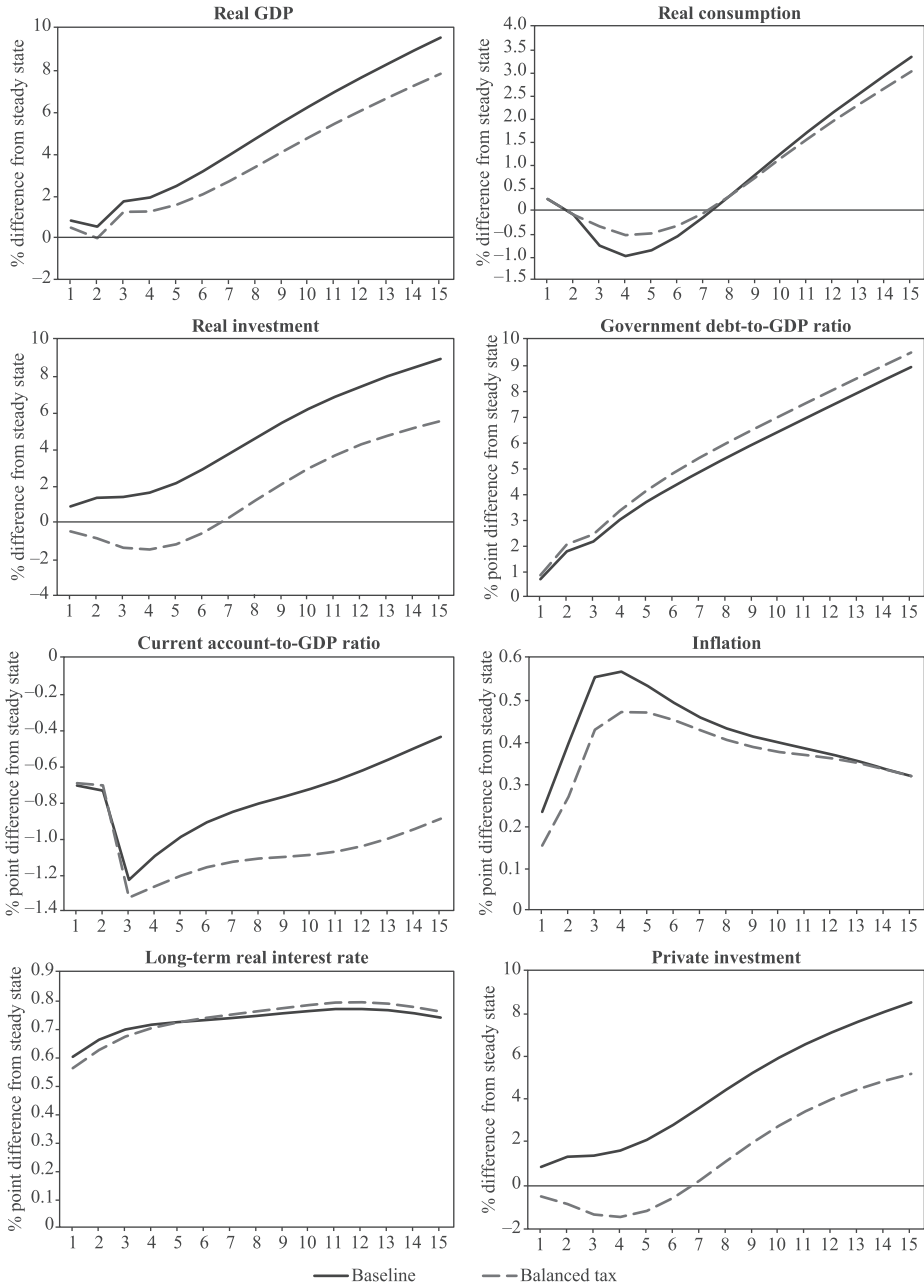


GDP = gross domestic product.

Notes: The x-axis shows the number of years since the start of the simulation. T = 1 is set to the year 2016.

Source: Author's calculations.

Figure 9. Alternative Revenue Mobilization Results



GDP = gross domestic product.

Notes: The x-axis shows the number of years since the start of the simulation. T = 1 is set to the year 2016.

Source: Author's calculations.

Chari, Christiano, and Kehoe (1994), which demonstrate the distortionary effect of capital and labor taxation on investment and labor supply. It has also been established empirically on average, as documented in Johansson et al. (2008) and Acosta-Ormaechea and Yoo (2012).

Rationalization of tax incentives has the potential to mobilize revenue while mitigating negative effects on growth. It has been shown that tax incentives in the Philippines are not well targeted (Botman, Klemm, and Baqir 2008). Their rationalization could raise revenue without raising statutory rates, thus mitigating the negative effects on private investment. Tax exemptions, however, are outside of the model in this paper.

3. No Contribution of Public Capital to Production

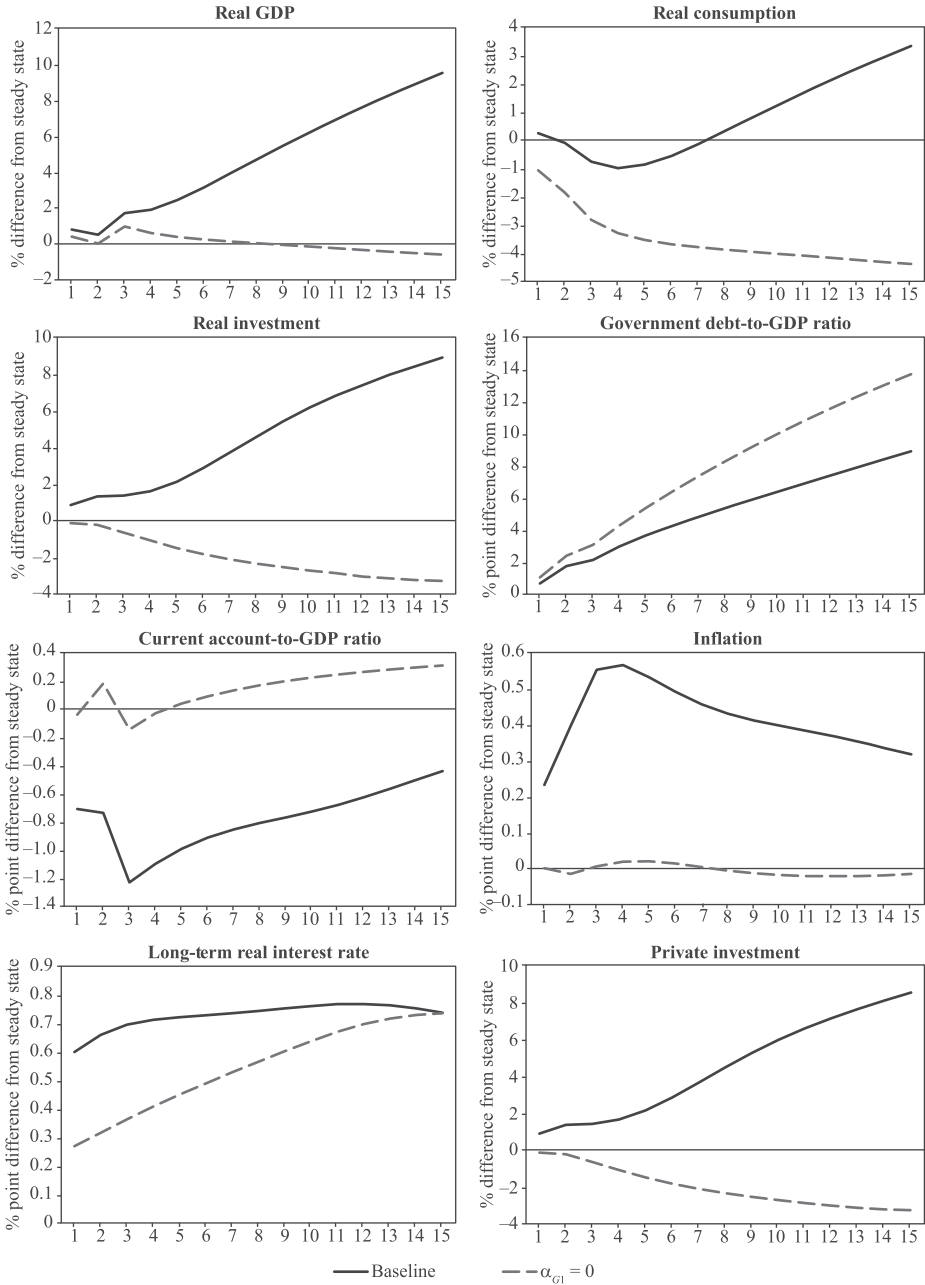
When $\alpha_{G1} = 0$ instead of the baseline value of 0.1, the model's dynamics change dramatically (Figure 10). Most importantly, economic growth is not sustainable without an increase in productivity. After an initial increase due to deficit-financed fiscal expansion, real GDP goes back toward the steady state. Consumption and investment are negatively affected as the borrowing cost increases more than the baseline, as shown in the higher paths of government debt and long-term real interest rate. Because this alternative scenario does not generate higher demand, inflation does not increase, and the current account does not worsen. While the long-term real interest rate increases due to an increase in public debt, the size of the increase is lower than that in the baseline scenario. This is because of the lack of a monetary policy response when there is no inflationary pressure, unlike in the baseline scenario.

V. Conclusion

This paper studied the macroeconomic implications of scaling up public investment in the Philippines. After benchmarking the Philippines relative to its neighbors in terms of the level of public capital, quality of public infrastructure, and public investment efficiency, the analysis used a dynamic general equilibrium model to quantitatively assess the macroeconomic implications of raising public investment and improving public investment efficiency.

The paper finds that the Philippines' public infrastructure investment is lower than its neighbors. Persistently low public investment in the Philippines has resulted in a low public capital stock relative to other ASEAN countries. While quantitative indicators show an uneven picture, survey-based indicators paint an unfavorable picture of the current state of public infrastructure in the Philippines. An outcome-based estimation of public investment efficiency suggests there is substantial room for improvement in emerging markets, including the Philippines.

Figure 10. Alternative Public Capital Contribution Results



GDP = gross domestic product.

Notes: α_{G1} refers to the output elasticity of public capital. The x-axis shows the number of years since the start of the simulation. T = 1 is set to the year 2016.

Source: Author's calculations.

Scaling up public investment results in sustained growth, driven by the particular structure of the GIMF model, in which improving public infrastructure leads to gains in the overall productivity of the economy, which crowds in private investment. In the baseline scenario that models the Duterte administration's infrastructure scale-up plan and comprehensive tax reform, the increase in public investment results in a 9.5% cumulative increase in real GDP relative to the steady state after 15 years. If no further tax reform takes place after the legislation that was passed in December 2017, the same public investment infrastructure increase would need to be financed by running higher deficits. Sustained output growth is realized in this alternative scenario as well, but the size is smaller due to the negative effects of higher borrowing costs from a higher level of public debt. Separately, improving public investment efficiency has substantial additional benefits. Eliminating half of the inefficiency would lead to an additional 2.1 percentage points in real GDP.

With a relatively low level of public infrastructure and a fast growing young population, addressing the large infrastructure gap is needed to raise potential growth and reduce poverty. This paper showed that increasing public investment spending can generate sustained output growth, and improving public investment efficiency can bring about substantial additional benefits. It also showed that deficit financing and tax financing will generate different outcomes, especially in consumption, investment, and output. Given the need to ensure debt sustainability amid the large spending needs in other priority spending areas for inclusive growth, continued efforts to mobilize revenue will be critical, by persevering with a comprehensive tax reform.

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