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John Cockburn · Yazid Dissou
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Infrastructure and Economic Growth in Asia

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Infrastructure and Economic Growth in Asia

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Summary

Public spending on infrastructure plays an important role in promoting economic growth and poverty alleviation. Empirical studies unequivocally show that underinvestment in infrastructure limits economic growth. At the same time, numerous other studies have shown that investment in infrastructure can be an effective tool in fighting poverty reduction. In that context, the financing of infrastructure has been a critical element of most economic growth and poverty reduction strategies in developing countries since the start of this millennium.

Several developing countries have recently started putting a policy emphasis on scaling up infrastructure investment. In this book, we provide a comparative analysis of the aggregate and sectoral implications of higher spending on infrastructure in three very different Asian countries: China, Pakistan, and the Philippines. In our analysis, we pay particular attention to the role of alternative financing mechanisms for increasing public infrastructure investment, namely distortionary and non-distortionary means of financing.

Using an intertemporal general equilibrium methodology that distinguishes between credit-constrained and unconstrained households, these studies tackle an important topic discussed in the literature on economic development: (i) how does infrastructure investment contribute to growth at the aggregate and sectoral level, and hence to poverty reduction; and (ii) what role do different financing methods of public spending on infrastructure play in facilitating economic development.

The comparative country analysis reveals that the effects of infrastructure investments on economic growth and poverty reduction can diverge significantly between countries and can also differ depending on the financing method used. However, a general conclusion emerges that public infrastructure investment generally increases growth and reduces poverty and inequality in the long run, although it can have negative impacts under certain circumstances and in some countries in

the short term. In addition, international borrowing is found to be better than tax financing in terms of job creation, improved productivity and complementarity with social protection measures.

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Introduction

John Cockburn, Yazid Dissou, Jean-Yves Duclos, and Luca Tiberti

Recent years have witnessed increasing interest in the relationship between economic development and poverty. An important reason for this has been the establishment of the Millennium Development Goals, which have set poverty reduction as a fundamental objective of development. The main factor explaining the salience of poverty reduction as a development goal is, in part, ethical. It is indeed widely considered ethically unacceptable that a large part of the world population still does not have the resources to achieve a basic level of living standards in an otherwise increasingly affluent world.

The most frequently advocated manner to achieve poverty reduction is through economic growth. Yet, growth is understood to be necessary but not sufficient to ensure a sustainable reduction in poverty. To do so, it must be inclusive in the sense that the poorest populations participate in and benefit from the growth process. Recent research has demonstrated that growth can vary tremendously in its power to reduce poverty, both across countries and over time. Its short-term and long-term poverty effectiveness depends on the structural changes that accompany the specific growth process. Even for those episodes in which growth does reduce short-term poverty, it is found in the literature that not all growth is equally inclusive of the poor. Hence, if one is interested in sustained poverty reduction and inclusiveness as an objective of development, then it is not enough to focus solely on growth.

Setting inclusiveness of growth as a development goal has three advantages. It reduces current poverty. It increases the impact of current growth on current poverty. It can finally increase future growth. Analyzing whether and how growth can be inclusive also enables a better understanding of long-term poverty. Long-term poverty is often linked to the difficulty for segments of the poor population to

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participate in the growth process, for example by finding better-paid employment in a growing sector. There is mounting suggestive evidence of the existence of poverty traps as higher return occupation or technology implies large sunk or fixed costs that are beyond the reach of the poor. Moving out of agriculture, where poverty rates are often much higher, is one example of such choices. Labor market participation, especially by women, who have, on average, lower possibilities to access loans, assets, new technologies, and lesser education, is another example. Any structural or policy induced trend that facilitates these transformations (i.e. shifts to higher value-added occupations and feminization of work) should foster pro-poor growth.

In this context, governments seek evidence and tools to assess the distributive impacts of alternative growth strategies. In this book, we develop and apply a new approach to simulate both the economy-wide impacts of such major investments and their household-level income and consumption impacts. More specifically, the approach combines a dynamic computable general equilibrium (CGE) model – which captures macro impacts as well as changes in prices, factor returns and employment – with a microsimulation analysis that maps these impacts to individual and household-level decisions and resulting incomes.

CGE models are widely recognized to be the best tool to conduct policy simulations of macroeconomic shocks and policies and to map out their impacts on specific sectors of production, factor markets, consumer prices, international trade and public finances. Indeed, governments in both developed and developing countries now routinely use CGE models to conduct simulations before enacting major policy reforms. Yet, the CGE literature is surprisingly poor in capturing growth – arguably the most important macro-economic shock or policy – including, for example, the dynamic impacts of trade liberalization through factor accumulation, technological diffusion, efficiency gains and increased foreign direct investment.

The macroeconomic literature has been far more productive in modeling growth, as these studies have been effective in capturing properly the transmission mechanisms between the economic environment and the accumulation of primary factors as well as productivity change. Yet these macro models are too aggregate to track down the more disaggregate sectoral and factor market impacts necessary to analyze the distributive consequences and, in particular, the participation of poorer populations in the growth process.

Most of the dynamic CGE models found in the inclusive growth literature are sequential in the sense that they are simply multi-period static models linked by a simple adjustment of the stocks of primary factors from one period to the other. In these models, saving and investment decisions, which are crucial in the growth process, are determined in an ad hoc manner like in static models, since households and firms do not for example take into account the future in their current-period decisions; they are myopic. This type of modeling strategy is unsatisfactory, as it does not make it possible to assess properly the impacts of government policies on factor accumulation as well as on their efficiency. Sequential CGE models cannot adequately capture the transmission mechanisms between changes in policy environment and investment decisions that are crucial for a good understanding of the

growth and distributive impacts of the proposed policy changes. There is a crucial need to develop a framework for policy analysis that can solve these deficiencies of recursive CGE models.

Intertemporal CGE models constitute a good candidate, as they provide a more realistic framework for modeling these crucial saving and investment decisions. Intertemporal CGE models assume that households and firms can behave rationally, for example by integrating their expectations of changes in current and future policy instruments or variables into current decisions. They can thus provide a coherent framework for analyzing changes in the economic environment that affect the accumulation of factors of production and their respective rates of return (wage rates for different categories of labor, returns to land, returns to capital...) over time.

The set of accumulable factors that intertemporal models can analyze is not limited to physical capital alone; these models can be used to analyze household decisions to invest in education (human capital) and hence government policies that affect, for example, the cost and returns to education. In the same vein, intertemporal models can be designed to capture the productivity effects of government spending on infrastructure.

Once the growth impacts are properly modeled and their impacts on key variables are correctly assessed, the poverty and inequality implications of proposed policy changes can be properly assessed using microsimulation techniques based on household survey data. We believe that this is an important methodological advancement since we are not aware of any model that examines the growth and distributive impacts of government policies in an intertemporal framework.

This approach is applied through the analysis of the distributive impacts of infrastructure investments in three large and divergent Asian countries: China, Pakistan and Philippines. Indeed, among possible growth strategies, investment in infrastructure is key. Infrastructure bottlenecks – in the quantity and quality of roads, railroads, ports, airports, communication facilities, etc. – constitute major constraints that increase the cost of purchasing inputs, bringing produce to markets, circulating information, networking among economic actors and that generally thus discourage investment and growth. Business surveys repeatedly cite infrastructure among the central criteria in national and international investment decisions.

Yet little is known about the distributive impacts of these investments and of the various mechanisms used to finance them. Indeed, governments can finance new infrastructure in a variety of ways – domestic or foreign loans, increases in a variety of taxes, cuts in other types of spending, etc. – that can be expected to have highly divergent impacts on poverty and inequality. The studies reported in this book develop and apply a rigorous framework to analyze the short- and long-term distributive impacts of infrastructure investment and of these different financing mechanisms in the case of three fast-growing Asian countries.

The book begins with a summary of the current state of the art in terms of theoretical and empirical analysis of infrastructure investments and their relationship to economic growth. This sets the background for the three case studies. The first of these sets out the methodological framework used in all three countries,

before applying it to the specific case of the Philippines. This is followed by applications to the cases of China and Pakistan. The book ends with a conclusion that compares and contrasts the key findings.

Beyond its contribution to the understanding of the growth and distributive impacts of infrastructure investments and their financing, the book constitutes a first step in providing tools to allow governments and other stakeholders to examine the role of other important growth strategies such as those that include investments in human capital (for instance, through education and health), research and development, agriculture, among many others.

Finally, this book is novel in another way. All three country studies were conducted by teams of researchers born and living in the countries they are analyzing. This gives them a unique and detailed understanding of the local economic and political context, which deepens their analysis and embeds their analysis and recommendations within local realities. Indeed, this book is the outcome of a program of research established by the Partnership for Economic Policy, a global network working to strengthen and promote a stronger voice for local researchers in national and international development policy debates.

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Infrastructure and Growth

Yazid Dissou and Selma Didic

Introduction

While a high rate of economic growth does not necessarily reduce inequality or poverty, there seems to be a consensus among researchers and policy makers that continuous, rapid economic growth is required for poverty alleviation. Governments around the world are continually looking for new strategies to increase the ability of their economies to produce goods and services. In this light, over the last two decades, economists have developed more sophisticated models to evaluate the potential economic impacts of different supply-side policies that aim to raise the productive capacity of the economy. Specifically, alongside modelling the main factors of production – physical capital and labour – these models seek to account for the concurrent use of non-traditional inputs, such as public infrastructure and education, as key contributing factors to economic growth.

The seminal papers of Romer (1986, 1990), Lucas (1988) and Barro (1990) have paved the way for the emergence of an entire class of endogenous growth models that seek to explicitly endogenize human capital accumulation and infrastructure as two of the main arguments of the aggregate production function. In this chapter, we provide a literature review on the modelling of infrastructure and education in growth models. At the theoretical level, we present and evaluate different strategies employed by endogenous growth economists to model human capital and infrastructure. At the empirical level, we discuss the empirical findings regarding the effects of infrastructure and education on growth and poverty alleviation, particularly in developing countries.

The remainder of this chapter is organized as follows. In the section "Infrastructure in Growth Models", we provide a rationale for the introduction of infrastructure into growth models. We then compare and contrast the different modelling

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strategies applied in a subset of macroeconomic literature that focuses on explaining endogenous growth in terms of public infrastructure. We conclude that section of the literature review with an assessment of the available empirical evidence regarding the effect of infrastructure on both growth and poverty alleviation with a special focus on developing countries. We use the same structure in the section "Education in Growth Models" with regards to education, and the final section provides our concluding remarks.

Infrastructure in Growth Models

Theoretical Considerations

Overview

Before discussing the various approaches used to model infrastructure in growth models, it may be useful to provide the rationale behind using infrastructure as an argument of an economy-wide production function. Three studies carried out by Aschauer in 1989 emphasized, among other things, the difference between productive and unproductive public expenditures, and helped catalyze an empirical debate on the effects of government expenditures on productivity. An interesting summary of the empirical results of this literature appears in the World Development Report (World Bank 1994), and shows that infrastructure seems to have no effect on economic growth in some cases and appears to generate returns in excess of 100 % per year in other cases. These strongly contrasting findings may be explained, in part, by the extent to which researchers have successfully tackled various econometric challenges in estimating the relationship between infrastructure and growth. Both Estache and Fay (2009) and Gramlich (1994) pinpoint significant econometric problems arising in the macroeconomic time series models used to estimate aggregate production functions. These include: common trends in capital per capita and output per capita, omitted variable bias (e.g. energy prices), reverse causality, network effects, heterogeneity and poor data quality.

Reviewing the relevant studies in the literature on the infrastructure-growth nexus, and acknowledging that the connection between infrastructure and growth appears to vary across countries and over time as well as within countries and within sectors themselves, Estache and Fay (2009) suggest that increasing empirical agreement exists regarding the growth-enhancing effect of infrastructure. For instance, in a review of evidence produced by Romp and de Haan (2005, p. 6), 32 of 39 studies on OECD countries find a "positive effect of infrastructure on some combination of output, efficiency, productivity, private investment, and employment." Moreover, 9 of 12 studies on developing countries indicate a significant positive impact (Estache and Fay 2009, p. 15). In addition, by employing an econometric technique that accounts for biases arising from omitted variables and

that explicitly accounts for the government budget constraint, Bose et al. (2007) find that government capital expenditures as a share of GDP are positively and significantly related to per capita income growth across a panel of 30 developing countries over the 1970–1980 period. However, current expenditures are shown to have an insignificant effect on growth in these countries over this timeframe.

In this context, it is important to highlight the various transmission mechanisms through which infrastructure affects growth. The most conventional channel, first described in Aschauer (1989) and Barro (1990), is that public infrastructure investments enhance private sector productivity. Indeed, Aschauer (1989) attributed the 1970s U.S. productivity slowdown to the lack of infrastructural investment. This direct productivity effect of infrastructure investment captures the idea that an increase in public capital stocks (relative to private capital) has a positive but decreasing impact on the marginal product of all factor inputs (such as capital and labour). Hence, the cost of production inputs falls and the level of private production increases. As Agenor and Moreno-Dodson (2006, p. 9) point out, "this scale effect on output may lead, through the standard accelerator effect, to higher private investment – thereby raising production capacity over time and making the growth effect more persistent."

Agenor and Moreno-Dodson (2006) identify two additional conventional channels through which infrastructure may affect growth, namely complementarity and crowding out effects. The first channel promotes growth through private capital formation. That is, public infrastructure raises the marginal productivity of private inputs, thereby raising the perceived rate of return on private capital and possibly also increasing private sector demand for physical capital. The second channel, crowding out, captures the idea that, in the short run, an increase in public capital stocks may displace or crowd out private investment. This negative crowding out effect of infrastructure may turn into a long-term negative effect if the decrease in private capital formation persists over time.

In addition to the three 'conventional' channels above, recent studies have also identified a variety of other channels through which public infrastructure may impact growth. Estache and Fay (2009) suggest that, in addition to the channels mentioned above, investment in public infrastructure can also impact investment adjustment costs, the durability of private capital, and both the demand for and supply of health and education services. In the same vein, Agenor and Moreno-Dodson (2006) argue that infrastructure may reduce investment adjustment costs via two channels: through complementarity between public capital and private investment and through the decreased costs associated with capital reallocation between sectors following a shock.

Maintaining the quality of public infrastructure may positively affect growth by improving the durability of private capital. That is, increasing government infrastructure maintenance spending allows the private sector to spend less to maintain its own capital and thus to allocate its investment capacity to other uses, thereby generating an additional growth effect. Better infrastructure is also found to improve access to health care and education. By improving health and education outcomes, the impact of public infrastructure on growth is magnified or

compounded due to the interconnected relationship between education and health (Agenor and Moreno-Dodson 2006). Healthier individuals tend to study more, while more educated individuals also tend to be healthier.

Moreover, Agenor and Moreno-Dodson (2006) add labour productivity as another channel whereby public infrastructure indirectly increases growth. Better access to infrastructural facilities means that workers can get to their jobs more easily and perform their job-related tasks more rapidly. Other studies have also found evidence of various positive externalities induced by public infrastructure, including increased competitiveness, greater regional and international trade, expanded FDI, and finally higher profitability of domestic and foreign investment flows which raises investment ratios and boosts growth in per capita income (Fourie 2006; Fedderke et al. 2006; Richaud et al. 1999).

Hence, at the theoretical level, infrastructure could be modeled as having an effect on any given measure of output via two channels: directly as a production factor and indirectly by influencing total factor productivity (TFP). The general production function would take the following form:

$$Y = A(K_{PUB})f(K, L, K_{PUB}) \tag{1}$$

where Y is output, K is private capital, L is labour, A is TFP and K_{PUB} is public capital.

Still, modelling infrastructure in the context of endogenous growth has been based on a more restrictive production function, generally excluding the indirect impact of infrastructure via TFP. Such a modelling approach, motivated by Barro (1990), introduces government infrastructure expenditures as an argument of the production function, and is justified by reasoning that private inputs (K) are not a close substitute for public inputs. However, his assumption that public expenditures is a flow variable brought a wave of criticism, starting with Futagami et al. (1993) who modified Barro's original model (1990) by considering productive public expenditures as a stock variable, much like private physical capital is.

We can distinguish between two theoretical approaches to modelling the impact of infrastructure on growth. The first treats government infrastructure expenditures as a flow variable which directly enters the production function. The second treats public infrastructure as accumulated capital, rather than as current flows, and thereby represents infrastructure as a stock variable in the aggregate production function.

Modelling Infrastructure as a Flow Variable

Barro (1990) models infrastructure in the context of a simple AK endogenous growth model. The two building blocks of his model are a production function that incorporates public services (an expenditure flows variable) as an input to private production, and a Ramsey equation that captures the representative

consumer's optimization behaviour. For most of his analysis, he assumes a Cobb-Douglas production function:

$$y/k = \Phi\left(\frac{g}{k}\right) \tag{2}$$

$$y = A \cdot g^{\alpha} k^{1-\alpha}; \quad 0 < \alpha < 1 \tag{3}$$

where y is output per worker, k is capital per worker and g is the per capita quantity of government purchases of goods and services. α is the (aggregate) production elasticity of public services; the function also defines the share of public services in total output. Production is assumed to exhibit constant returns to scale with respect to the private stock of capital and the flow of public services provided by the government. Barro (1990) makes a theoretical assumption that the government is not engaged in production and does not own capital; rather, it buys a flow of output (e.g. services of highways, sewers, etc.) from the private sector. These services are paid for and made available to households and correspond to the input g. Moreover, Barro (1990) argues that it is the amount of government purchases per capita that matters since few government services are actually non-rival.

The second building block in the model is the consumption growth rate equation, derived from the utility-maximization problem of the infinite-lived household:

$$\frac{\dot{C}}{C} = \frac{1}{\sigma}(f' - \rho) \tag{4}$$

where f' is the marginal product of capital.

The income tax rate is set to finance the chosen level of expenditure:

$$g = T = \tau y = \tau k \Phi\left(\frac{g}{k}\right) \tag{5}$$

where T is government revenue and τ is the tax rate. By normalizing the number of households to unity, g represents aggregate expenditures and T aggregate revenues. This equation constrains the government to run a balanced budget.

Given the production function specified in Eq. 1, the marginal product of capital is:

$$f' = \Phi\left(\frac{g}{k}\right)\left(1 - \Phi' \frac{g}{y}\right) = \Phi\left(\frac{g}{k}\right)(1 - \eta), \tag{6}$$

where η is the elasticity of y with respect to g (for a given value of k), such that $0 < \eta < 1$. Since income is taxed to provide for public services, Eq. 4 is modified as follows:

$$\gamma = \frac{\dot{c}}{c} = \frac{1}{\sigma}\left[(1-\tau)\Phi\left(\frac{g}{k}\right)(1-\eta) - \rho\right] \tag{7}$$

Provided that the government sets g and T to grow at the same rate as y, g/k and η, then γ will be constant. As a consequence, in the steady state,[1] per capita consumption, per capita output and per capita capital will grow at the same rate, a positive function of the marginal product of capital.

By differentiating Eq. 7 with respect to g/y,

$$\frac{d\gamma}{d\left(\frac{g}{\gamma}\right)} = \frac{1}{\sigma}\Phi\left(\frac{g}{k}\right)(\Phi' - 1) \tag{8}$$

Barro (1990) shows that the decision to invest in public infrastructure has two opposing effects: a positive one, where an increase in productive government spending increases the marginal product of private capital and thus generates sustained per capita growth; and a negative one, where an increase in financing of public infrastructure by taxing income reduces per capita growth. The negative effect dominates when government size is large, while the positive effect dominates when government is small.

In Barro's (1990) model, to maximize growth, the government must set the tax rate equal to the elasticity of the public services g in aggregate production. In maximizing growth (Eq. 7) with respect to the tax rate τ, the government must set $\tau^* = \Phi = \alpha$. In the context of the model, this condition not only corresponds to maximum growth, but it also maximizes lifetime utility or welfare. In other words, to maximize the national growth rate and social welfare, the government sets the optimal level of the income tax financing public services as a share of national income to be equal to the contribution of public services to aggregate output in a competitive economy (i.e. the elasticity of the public services g in aggregate production). This result is crucially dependent on the Cobb-Douglas functional form used to represent technology.

This baseline approach to modelling infrastructure as a flow variable has been adopted and extended by several other authors. Some of these include Rivas (2003), Eicher and Turnovsky (2000), Yakita (2004), Ohdoi (2007), Chen and Lee (2007) and Park and Philippopoulos (2002). The main advantage of modelling infrastructure as a flow variable is that it produces highly tractable models (Fisher and Turnovsky 2013). Agenor (2007) observes that the flow specification generates results that are not qualitatively very different from studies employing the stock specification of infrastructure. However, it has been argued that as long as one is interested in modelling the impact of infrastructure on growth, the stock variable specification may be more appropriate or plausible. One of the reasons for this is that specifying infrastructure as a flow variable within the production function

[1] The economy is always in the steady state, i.e., there are no transitional dynamics.

Public Infrastructure and Economic Growth in Pakistan: A Dynamic CGE-Microsimulation Analysis

Vaqar Ahmed, Ahsan Abbas, and Saira Ahmed

Introduction and Background

The role of infrastructure in economic growth and welfare has been studied extensively across the literature over the past three decades. Post World War II reconstruction presented a model where governments invested in economies in order to create an enabling environment for the private sector. This led to infrastructure being viewed as something along the lines of a public good, and in many countries its provision became the sole responsibility of the state.

Later, many experts realized that infrastructure needs to be divided into public works (mainly construction of infrastructure) and public service delivery (provision of utilities such as electricity and water).[1] While the former remains a public sector domain in developing countries, public service delivery has seen the involvement of the private sector through unbundling of supply chains.

More recently in the wake of commodity price hikes and the global financial crisis, developing countries have found it hard to sustain investment in infrastructure (Planning Commission 2011). This has led to the closure of mega projects, particularly in the energy and water sectors, in association with escalating costs, time overruns, etc. Governments are increasingly turning to alternative modes of financing, including private sector participation such as public private partnership models and build-operate-own models. However, even these modes of financing have proven challenging as most developing countries have yet to come up with a legal and regulatory framework for such transactions. Until such a framework

[1] See World Bank (1994) for more on this.

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exists, infrastructure financing will continue through foreign aid, collecting taxes and imposing development and user charges (Lin 2011).

As a developing country, Pakistan is also faced with infrastructure issues which can be classified into broad headings of quantity, efficiency and financing. Inter- and intra-regional inequalities exist in access to even basic infrastructure. This situation has forced people to migrate to cities in search of increased opportunities. Today, Pakistan has the fastest urbanization rate in all of South Asia. This has put pressures on already stressed urban infrastructure.

In view of the above mentioned, this paper investigates two modes of financing public infrastructure: international borrowing and production taxes. The next section provides a brief literature review on the subject and is followed by discussion of the current state of infrastructure in Pakistan. Section "Data and Parameterization" discusses the data and parameterization. Section "Results" explains our results and the section "Conclusion" concludes with policy recommendations.

Infrastructure and Economic Growth

We divide the literature into two quantitative streams, primarily for methodological ease. The first stream uses econometric tools to study the impact of infrastructure on growth and the second uses a computable general equilibrium model.

Global Evidence

The World Bank (1994) provides important insight into infrastructure dynamics from an availability, efficiency and financing point of view, but it defined infrastructure from the narrow perspective of public services comprised of electricity, energy and water, as well as public works, primarily roads and other transportation infrastructure such as rail, port and airports. The seminal work by Aschauer (1989) shows significant impact of public capital on growth has results which are contrary to those of Holtz-Eakin (1994). Aschauer (1998) later suggested, for the case of Mexico, that large public investments are an insufficient condition for growth, and must be complemented by policies regarding the financing and use of infrastructure. Most of the earlier literature is silent on the impact of infrastructure on poverty and inequality.

Looking at infrastructure through disaggregated spending is also important. Public expenditures on connectivity and ICT play an important role in facilitating growth processes. Connectivity between people and places has been shown to overcome urban–rural, gender and human capital disparities. Lall (2006), taking a pooled dataset of Indian states, shows that spending on transport and communications infrastructure are significant determinants of regional growth. There are positive externalities from investments by local and neighbouring states. Devarajan

et al. (1996) had previously found a negative and significant relationship between economic growth and transport and communications expenditures-to-total expenditures ratio in their sample of countries, and attributed this to the possibility that overinvestment in transport and communications makes such expenditures relatively unproductive. Canning and Pedroni (2008) analyze a panel of countries from 1950 to 1992 and show that infrastructure does not tend to cause growth in the longer run, although there is variation across countries. Infrastructure is undersupplied in some countries and oversupplied in others.

In the same cross-country regression tradition, Sanchez-Robles (1998) used the quantity of public infrastructure stock (measured through indices) rather than public infrastructure expenditures and found a positive and significant relationship. The author stressed the need to ensure the efficiency of public investment for optimal absorption. Accountability and civil service reforms need to be established as part of robust monitoring and evaluation for projects funded through either taxation or foreign aid (Planning Commission 2011).

Straub et al. (2008) show for East Asia that the failure to find a significant link between infrastructure, productivity and growth may arise because investments in infrastructure were made to relieve constraints and bottlenecks (where they existed) rather than to directly encourage growth.

In time-series studies, Nketiah-Amponsah (2009) show for Ghana that aggregate government expenditures over 1970–2004 negatively impacted economic growth. More specifically, disaggregated (short run) health and infrastructure expenditures positively affected growth and education expenditures negatively impacted growth. The political economy variables such as governance and political instability were significant in explaining growth. Sahoo and Dash (2009) also show for India that the stock of infrastructure positively contributes to growth with unidirectional causality from infrastructure development to output growth.

Some existing CGE studies investigate the economy-wide impact of public infrastructure. Rioja (2001), in general equilibrium studies on Brazil, Mexico and Peru, show that these countries underinvested in infrastructure during 1970s and 1980s. The simulations suggest that infrastructure can positively impact output, private investment and welfare.

Estache et al. (2009) show for Mali that foreign aid-funded infrastructure does produce Dutch Disease effects, but that the negative impacts differ by the type of investment, while economic growth attenuates these negative effects.

Dissou and Didic (2011) found for Benin that the crowding out effects of public infrastructure is sensitive to the mode of financing chosen by the government. Overall, their findings suggest that public investment in infrastructure can support private investment and sustain capital accumulation. The positive impact of public investment on private investment can be explained through the infrastructure financing channels such as public private partnerships and sub-contracting which in turn tend to crowd-in private investment.

Pakistan's Context

In the case of Pakistan there are several studies showing a negative or insignificant impact of aggregate public investments on growth. These include Ghani and Din (2006), Rehman et al. (2010) and the Planning Commission (2011). Sadly, not enough work has been done to quantify the economy-wide impact of public expenditures at a disaggregated level. However, some background studies do estimate the infrastructure deficit in Pakistan (Samad and Ahmed 2011).

World Bank (2007) reported that Pakistan's key infrastructure shortages lie in the water, irrigation, power and transport sectors. The country is amongst the most water-stressed in the world and rehabilitating current wear and tear in the water sector will require more than $7 billion in maintenance over the next 5 years. Pakistan faces severe power shortages of approximately 5,000 MW and per capita energy consumption is among the lowest in the world, slowing industrial growth. The inefficiencies of the rail, road, port and aviation sectors are now costing the economy over 4 % of GDP.

While various governments have tried to pump capital in maintenance and incremental infrastructure with the help of development partners, capacity to implement these programs has remained weak. The lack of suitable human resources, poor planning and management skills and an inability to attract external implementation resources has led to time and cost overruns. Over half of the annually trained engineers migrate abroad for employment (due to significant wage differences) and declining economic growth has made it impossible to attract them back (Mehmood et al. 2013). Corruption in infrastructure projects has been estimated to be 10–15 % of the project value. The average project runs three times longer and two times more expensive than the initially planned cost (Pasha 2011). This is attributed to: external verifications (National Accountability Bureau, Chief Minister's Inspection Teams, Parliamentary Committees etc.); audit procedures; local government procedures (mining, land acquisition, forest department etc.); law enforcement agencies; and corruption.

ADB (2008) explains that Pakistan had a successful experience with privatization of state-owned telecom enterprise. This not only attracted foreign direct investment but also ensured efficiency through competition. However, excessive regulation has impeded replication of this experience across other sectors, such as energy, where the government continues to subsidize operations. Also see SBP (2007) for more details in this regard. JBICI (2007) describes how productivity is declining among 45 % of workers, primarily in the agricultural sector, due to the dilapidated state of irrigation infrastructure. The report shows that access to irrigation infrastructure helps to keep the incidence of chronic poverty at lower levels. Furthermore, improving, lining and upgrading watercourses will help improve water efficiency.

Pakistan faces a major threat from climate change. The country has witnessed regular instances of floods, droughts and earthquakes. The Asian Development Bank, World Bank and the One UN office jointly conducted the damage assessment

for the 2010 floods and reported aggregate damages of PKR 855 billion. The reconstruction costs (which includes rebuilding/renovating lost infrastructure) range from an estimated US$6.8 to 8.9 billion. The report recommends that this should be seen as an opportunity to build stronger and energy efficient infrastructure for future growth and welfare.

Recent Issues

Infrastructure affordability: Sustaining infrastructure growth has been difficult for developing countries over the medium to long run. Lin (2011) identifies three reasons for the slowdown of infrastructure growth in China after 1978. These include: low government spending, decreased investment incentives for state enterprises and diminished ability of local government to mobilize rural resources. Alternative infrastructure financing mechanisms mentioned by the authors include domestic and foreign debt, taxes, fees and user charges, profits of state enterprises and labour services.

Complementary Reforms: Dodonov et al. (2002) analyze transition countries (with special reference to Ukraine) and show that infrastructure reforms in these countries should be linked with tariff reforms along with an overall national policy of open commercialization and deregulation of infrastructure sectors. A failure to do so may prevent absorption of public and private funds into infrastructure development.

Macroeconomic stabilization: Increased globalization has rendered many developing countries prone to terms of trade shocks. The usual prescription given by multilateral organizations for countries finding themselves in balance of payments difficulties is contradictory fiscal policy. Ramirez (2004) questions stabilization policies in developing countries which disproportionately reduce public infrastructure spending in order to comply with reductions in fiscal deficits.

General equilibrium effects: It is important to note the relative superiority of general equilibrium models in studying the economy-wide, sectoral and disaggregated impacts of infrastructure investment and endowment. Several studies providing such important insights should be mentioned here: Giesecke et al. (2008) who study macroeconomic outcomes under alternative public infrastructure financing arrangements (also see Boccanfuso et al. 2012); Adam and Bevan (2006) look at the role of aid in public investment and possible Dutch disease effects (also see Levy 2007).

Table 1 Global infrastructure ranking, 2011–2012

	Transport	Electricity and telephony	ICT	Education	Health	Security	Public institutions
Malaysia	14	48	57	91	52	48	32
China	29	69	74	93	71	68	46
India	35	116	117	109	109	89	72
Sri Lanka	52	79	100	89	61	59	49
Pakistan	80	126	111	126	111	137	111
Philippines	104	101	93	83	97	117	112
Benin	115	118	120	123	120	95	91
Bangladesh	117	137	132	118	107	103	112

Source: Global competitiveness report, 2011–2012

State of Infrastructure in Pakistan

Infrastructure provides a backbone that sets an economy on the path towards sustained economic growth. The provision of basic and efficient infrastructure in transport, communications and utilities such as electricity provides an enabling environment for the private sector which then takes the lead in the growth process. Table 1 paints a dismal picture for Pakistan in terms of its global infrastructure ranking. While Pakistan has invested in public assets, poor governance (poor accountability, monitoring, stakeholder participation, etc.) continues to plague these assets (Planning Commission 2011).

Infrastructure in Pakistan was traditionally financed through public sector financing, much of which was actually leveraged through foreign aid. However given the rise in global commodity prices, and in particular its effects on input costs in the construction sector, it became almost impossible for the government to afford the rising unit cost of infrastructure financing. In the late 1990s, it was realized that Pakistan would not even be able to maintain the existing infrastructure without deregulating, privatizing and liberalizing this sector for domestic and foreign private investment. In absolute terms, these measures did increase capital formation in the transport and communication sectors.

Road Transport

For transportation, Pakistan relies heavily on roads which handle 96 %[2] of total freight traffic.[3] The federal budget also exhibits a strong bias towards financing construction and maintenance in the road sector. Since 1996, the total length of roads has increased by 13 % to 259,618 km in 2010, 179,290 of which were paved

[2] Economic Survey of Pakistan, 2009–2010.

[3] This section draws from our companion paper Haque et al. (2011).

(referred to as high type). The national highways and motorways network constitutes 4.2 % of the total road network and handles more than 85 % of all road traffic in Pakistan. The majority of Pakistan's highways and motorways network is along the North–south corridor with the N-5 acting as the main artery and carrying 55 % of inter-city traffic in the country. Around 60 % of the network is in poor conditions. This is mainly due to poor maintenance, vehicle overloading, overinflated truck tires and the significant shift from railways to roads in both passenger and freight transport.

Over the past few years, there has been a gradual increase in the length of high type roads and a decline in low type roads (unpaved), with most low type roads being converted to high type (Table 2). The National Highway Authority (NHA) has been carrying out extensive road development projects: 30 new projects to extend the road network by 1,000 km inclusive of bridges, flyovers, and interchanges have started. The NHA has also managed to increase its toll revenue by 36 % over the past year.

Another problem in road transportation is the corruption in the policing system. Traffic laws are lax in Pakistan and the policemen are often underpaid and have long working hours. Corruption is also rampant on the infrastructure development side of road transportation. Roads are often deliberately left weak, susceptible to rapid deterioration, so that contracts can be repeatedly given to the same people.

For the impact and transmission channels of how investment in road infrastructure leads to productivity, economic growth and poverty reduction, we can look to Montolio and Solé-Ollé (2009) and Fan and Chan-Kang (2005). In the case of Pakistan, see Siddiqui (2008) and Chohan et al. (2011).

Rail Transport

Railways around the world have an edge in long haul and mass transportation of both goods and passengers. In Pakistan, it was the primary mode of transport until the 1970s. Since then its share has declined due to the shift in government's preference towards road rather than rail transport. Over 2005–2010, budget expenditures on railways totalled just PKR 45.5 billion whereas for national highways it stood at PKR 155 billion. Its share of inland traffic has fallen from 41 to 10 % of passengers and from 73 to 4 % of freight traffic.

Timely and safe transportation of merchandise from the port in the south for delivery in the north is a major issue given the poor infrastructure in road, rail, warehousing, etc. After the creation of the National Logistic Cell (NLC) to clear the goods from Karachi port, Pakistan Railways (PR) has always found it difficult to maintain its historical position. In Table 3, we see a gradual decrease in the number of passengers and freight moved as well as the length of track and the number of wagons and locomotives.

Table 2 Road sector in Pakistan, 1997–2009

	High type		Low type		Total	
Year	Length	% change	Length	% change	Length	% change
1997	126,117	6.5	103,478	3.6	229,595	5.2
1998	133,462	5.8	107,423	2.5	240,885	4.9
1999	137,352	2.9	110,140	−4.4	247,484	2.7
2000	138,200	0.6	105,320	−2.4	240,340	−2.9
2001	144,652	4.7	102,784	−3.7	249,972	4.0
2002	148,877	2.9	98,943	−1.4	251,661	0.7
2003	153,255	2.9	97,527	−2.2	252,168	0.2
2004	158,543	3.5	95,373	−4.1	256,070	1.5
2005	162,841	2.7	91,491	−5.6	258,214	0.8
2006	167,530	2.9	86,370	−2.7	259,021	0.3
2007	172,827	3.2	84,038	−1.1	259,197	0.1
2008	175,000	1.3	83,140	−3.4	259,038	−0.1
2009	177,060	1.2	80,328	2.5	260,200	0.4

Source: Economic survey of Pakistan, 2009–2010

Table 3 Pakistan rail sector

Rail sector indicators	1991	2009	% change
Route travelled (km)	8,775	7,791	−11.2
Passengers carried (millions)	84.9	82.54	−2.8
Freight carried (million tonnes)	7.72	6.94	−10.1
Locomotives	753	551	−26.8
Freight wagons	34,851	17,259	−50.5

Source: Pakistan Railways 2011

A significant reduction in business activity during the last year partially attributable to security issues, ultimately reducing government revenues. There has also been a shortage of active locomotives due to non-procurement of spare parts. Much of the rolling stock damaged during the December 2007 riots has yet to be repaired. This delay has been mainly due to a reduction in Public Sector Disbursement Program disbursements and slow corporatization. The majority of the engines recently acquired from China are also facing maintenance issues leading to closure of several routes. Earnings are still low and are hardly enough to cover the cost of salaries and pensions, respectively equal to PKR 14 billion and PKR 7 billion per annum. In 2008–2009, earnings grew by 16 % compared to the year before but since have worsened to pre-2004 levels. Despite improved performance during the last decade, losses remain high, at PKR 10 billion in 2006–2007 and over PKR 12 billion in 2007–2008.[4]

[4] For detailed discussion of the growth and productivity effects of rail infrastructure investment, see Crafts (2011) and Banister and Thurstain-Goodwin (2010).

Aviation

In 2007–2008, Pakistan's 35 airports handled more than 14 million passengers and 318,652 million tons of cargo.[5] Jinnah International Airport in Karachi is the busiest, but the Lahore and Islamabad airports also handle significant amounts of domestic and international traffic.

Compared to 2005–2006, both cargo and passenger traffic have fallen. Total passenger traffic has declined by 0.4 million passengers and cargo traffic decreased from 347,674 to 318,652 million tons. Most of this is attributed to the reduction in domestic traffic associated with the poor situation regarding the economy, political instability and law and order.

The total number of domestic and international airlines operating in Pakistan (28) remained the same, although two Pakistani airlines (Aero Asia and Royal Airlines) are no longer in business. This is attributed not only to mismanagement but also to the government's close association with state-owned Pakistan International Airlines (PIA) and the uncompetitive environment for other domestic airlines. PIA accounts for 73 % of all passenger traffic and captures nearly the entire market for freight in the aviation sector. International routes are covered by frequent flights to the UK and Middle Eastern countries. Demand on these routes mainly comes from Pakistani workers abroad. Connections to other countries generally remain infrequent and time consuming.

Due to extra security checks on airlines flying via Pakistan and the recent slowdown in the aviation sector, international airlines largely remain hesitant to explore the Pakistani market. Currently, no Pakistani airline flies direct to any African or Latin American country and the only flights connecting the country to Southeast Asia are two direct flights per week to Malaysia. Connecting flights to other destinations are available but it takes much longer and arrival times are highly uncertain.

Domestic connectivity is also constrained by inadequate airport handling and slow check-in procedures. This leads to lengthy flight delays, making air travel highly inconvenient, particularly given the much higher ticket prices. The domestic market is strong dominated by PIA as a result of preferential route allocation, tax benefits and other protectionist policies, making it difficult for new carriers to enter the aviation sector.[6]

[5] Civil Aviation Authority. http://www.caapakistan.com.pk/, access October 12th, 2012.

[6] For discussion on how air transport infrastructure investment facilitates economic growth, see Hong et al. (2011) and Marazzo, Scherre and Fernandes (2010). For Pakistan see Haque et al. (2011).

Table 4 Electricity production (megawatts)

Year	Installed capacity (MW)	Generation (MW)
2001–2002	17,799	8,265
2002–2003	17,798	8,639
2003–2004	19,257	9,235
2004–2005	19,384	9,787
2005–2006	19,450	10,705
2006–2007	19,420	11,231
2007–2008	19,420	10,943
2008–2009	19,786	10,484
July–March		
2008–2009	19,575	6,940
2009–2010 (e)	19,650	7,517

Source: Economic survey 2009–2010

Energy

Pakistan has been facing significant energy shortages since 2008–2009. The main issue has been the complicated market structure, not capacity constraints. Between 2003 and 2007, energy prices were held fixed, making the private sector more dependent on government subsidies to accommodate variable production costs. Sharp increases in oil and gas prices throughout 2008 put enormous upward pressure on cost structures in the power generation sector. Since tariffs also remained unchanged, much of this burden had to be borne by the government in the form of increased subsidies. However, rising costs in the war on terror along with a slowdown in GDP growth reduced government resources, ultimately leading to the emergence of the inter-corporate debt problem.

Table 4 shows that electricity generation began to decline from 2006 to 2007 onwards despite an increase in overall installed capacity during the same period. Fortunately, data for the last 2 years (shown only for July–March in these 2 years) shows a positive trend.

Despite frequent increases in electricity tariffs in the last 2 years, a wide gap still exists between generation cost and recovery. Before the increases in tariffs, this gap was estimated at around 30 %. Steps towards elimination of subsidy-based tariff regime have helped reduce inter-corporate debt to 120 billion PKR as of May 2010 compared to 216 billion rupees in June 2009.[7]

[7] The link between demand for energy and economic growth has been studied at length in Lee and Chang (2008), Apergis and Payne (2009) and Wolde-Rufael (2008). For Pakistan's case see USAID (2007) and Hye and Riaz (2008).

Water and Sanitation

The quality of physical infrastructure continues to deteriorate and its coverage is exceedingly inequitable; the poor stand deprived and disadvantaged, and pay exorbitant prices to water vendors. The present coverage of water and sanitation facilities are respectively said to be 85 and 65 % in urban areas, but the accuracy of these statistics is often questioned.

Management of service delivery is also a big issue. An important deficiency in this regard has been a lack of local government capacity to generate enough funds for the operation and maintenance of existing networks. There are often no incentives for improved operations and management (O&M) and assets tend to deteriorate much earlier than their usual life. For major projects, local governments are dependent on the assistance of provincial and federal governments. Public sector investment in the sector is very low, at 0.25 % of GDP. In spite of the government's interest in and encouragement of private sector involvement, its' participation has been low.

Local governments suffer technical, financial and administrative weaknesses in planning and in operations and maintenance-related issues, especially in relation to energy requirements. These local government departments are both overstaffed and have an insufficiently trained workforce.

Moreover, underground water reserves are depleting rapidly due to high withdrawal and surface water is exposed to municipal discharges and pollution. Cities have increasingly scarce and poor quality water supplies. Meanwhile, a full 35–40 % of water supplies are lost through leakages in water distribution networks. Water treatment facilities are also limited.

Sewage is collected through open drains in most cities, and is then discharged untreated into rivers, streams, lakes and canals. These waterways are often used as sources for urban water supply schemes. Collection through piped networks is limited to few large cities where coverage is also selective and sewage treatment rare. In small towns, open defecation is not uncommon.

Only 5 % of households have proper access to municipal garbage collection systems, and arrangements to dispose of this waste at properly developed landfill sites are often lacking. Uncollected garbage accumulates in the streets and in open spaces between houses, where scavengers extract the reusable and recyclable materials and leave the rest to rot.[8]

Government Infrastructure Strategy

Given low domestic resource mobilization and low expected tax revenues, public investment has been consistently declining. The existing public sector development programme allocates a very high share of its resources to civil work (almost 60 % in

[8] Discussion on investment in the water sector and its impact on economic growth may be seen in Barrios et al. (2010) and Grey and Sadoff (2007). In case of Pakistan, see World Bank (2008).

2011), leaving little for social sectors such as education and health. Public investment has been spread thin across sectors and regions, making it difficult to focus strategy. The governance of public investment also requires immediate attention. Issues such as electricity and gas shortages result from management problems, not capacity limitations.

The government has been advised to unbundle service delivery of most public utilities. Public investment should be prioritized and sequenced. Public sector projects nearing completion should be given priority. Key infrastructure projects for energy, water and transport production inputs will require participation of the private sector, so rules for public private partnerships should be made as straightforward as possible. Finally, projects to remove regional disparities should be initiated, potentially enabling greater labour force participation, particularly in war torn areas.

Due to the fiscal crunch and a lack of coordination between government departments, the National Trade Corridor project was abandoned in 2011. The project had earlier been envisaged as having an integrated focus on transport, logistics and economic growth. The Planning Commission (2011) realized that resource constraints meant that new investment in infrastructure was hard to come by, and that the government should thus shift focus more toward improving management of existing infrastructure. To some extent, this remains true as many public sector monopolies in the provision of infrastructure have underperformed due to structural inefficiencies. This document also talks about deregulating the rail, road and aviation sectors to allow private sector participation. Interest has already been expressed by China, India and other East Asian economies for direct investments in transport, logistics, and oil and gas exploration.

It is pertinent to mention that autonomous or semi-governmental bodies such as WAPDA, OGDCL, etc., outline their own investment plans according to their own resource availability and projected cash flows. Provincial governments also spend directly on infrastructure; some have outlined their infrastructure priorities in provincial economic reports.

Data and Parameterization

The CGE-microsimulation approach adopted for this study is discussed in chapter on The Philippines case study. For more details, refer to Dissou and Didic (2011) for the CGE model and to Cockburn et al. (2011) for the microsimulation module.

The dynamic CGE model is calibrated to the benchmark data in the 2007–2008 Pakistani social accounting matrix, where 12 production sectors and 12 commodities are identified. For the microsimulation model we use the Pakistan Social and Living Standards Measurement Survey (PSLM) 2007–2008. Some of the external parameters used in the CGE model include: substitution elasticity of the CES household function (0.7 %), substitution elasticity of first- and second-level CES production functions (0.5 % and 0.4 %), the depreciation rate (12 %), output elasticity of

public capital (0.3), the share of public investment in total investment (28 %), the population growth rate (1.8 %), the world real interest rate (6 %) and the share of constrained households in: consumption (57 %), labour income (71 %), income taxes (10 %) and government transfers (10 %). Most of these external parameters are in line with previous CGE studies on Pakistan (such as Ahmed and O' Donoghue 2010). For details on comparable discussion of parameters, please see UNIDO (2009).

Simulation design: We simulate a 4 % increase in the public infrastructure investment-to-GDP ratio. This increase brings the public infrastructure investment-to-GDP ratio back to the levels observed prior to the food, fuel and financial crises. This simulation follows the Planning Commission's *Framework for Economic Growth* by studying the impact of a 4 % increase in this ratio financed by either (a) international borrowing or (b) a production tax.[9] We look at the short, medium and long term impacts in both of these policy experiments.[10]

Results

Financing the 4 % increase in the public infrastructure investment-to-GDP ratio by an increase in international borrowing generates a real GDP growth higher right from the very first period because foreign savings finance the borrowing used to increase investment, with a 1.3 % growth in the overall long-run. If we disaggregate by GDP components, total investment and household consumption in the long run are simulated to grow by 3.4 and 1.2 % respectively (Table 5).

Infrastructure investment appears to have redistributive effects, given that the rise in consumption is relatively higher among constrained households than non-constrained households. Additionally, constrained firms in this scenario invest more starting in the first period (again reflecting increased savings available for investment purposes).

Wages rise throughout the time horizon, while the price of capital declines over time. The lower cost of capital facilitates long run expansion of both public (+5 %) and private (+2 %) capital stocks. In the long-run, the private capital stock increases by relatively more among non-constrained firms due to their access to financial services.

[9] The reason for choosing the production tax is that usually, of the many indirect taxes, this is one of the easiest to implement in developing countries with fewer politically unfavorable implications (given that it is linked with growth in value added). However this tax also has highly distortionary effects on production and consumption.

[10] All variables are expressed in "per efficient workers" terms (per capita + technological progress). If we suppose that in the business as usual (BAU) scenario all variables rise by the population growth and technological progress rates, and if we express all variables in "per efficient workers," then under the BAU variables are constant over time and correspond exactly to the base year. All results presented below should thus be read as changes relative to the base year.

Table 5 Macro impacts of 4 % increase in public infrastructure investment-to-GDP ratio (international borrowing), percentage change wrt base scenario

Variable	First period	Short run	Long run
Real GDP	0.31	0.69	1.29
Wage rate	0.23	1.04	2.26
Price of capital goods	0.39	0.35	0.08
Rental rate of capital, constrained households	0.69	1.43	1.31
Total household consumption	0.07	0.46	1.16
Constrained	0.45	0.93	1.58
Non-constrained	−0.07	0.04	0.37
Total Investment	1.65	2.33	3.35
Public	3.92	4.35	5.26
Private	0.75	1.52	2.59
Constrained	0.06	0.58	1.50
Non-constrained	1.05	1.93	3.07
Total capital stock		0.85	2.81
Public		1.81	4.64
Private		0.44	2.01
Constrained		0.13	1.13
Non-constrained		0.59	2.45
Total exports	−0.50	0.23	1.80
Total imports	0.84	1.31	1.93
Real exchange rate	−0.28	−0.24	−0.03
Foreign savings as % of GDP	−2.73	−2.74	−2.83
Total income of constrained households	0.45	0.93	1.58
Labour income	0.23	1.04	2.26
Capital income	0.69	1.57	2.45
Government revenues	1.63	2.03	2.55
Additional foreign borrowing as % of GDP	0.21	0.17	0.09

Source: Authors' computation based on simulation results

On the trade side, the increase in foreign reserves leads to real exchange appreciation. In the first period, this reduces export price competitiveness, indicating a Dutch disease-like effect. In the first period, exports decline by 0.5 % and imports increase by 0.84 %. In the long run, both exports and imports increase because greater availability of investment funds and a higher stock of infrastructure improve supply side conditions. The increase in the international borrowing-to-GDP ratio tapers off (declining by 0.09 % in the longer run) due to reduced borrowing needs to fund incremental infrastructure. This is also attributable to rising government revenues in the long run. The increase in government revenues is higher in the long run (by 3 %) than in the previous simulation because foreign savings have a greater growth impact. The main sources of additional revenue are direct taxes, consumption taxes and import taxes.

Gross output grows by most in the construction and non-textile manufacturing sectors (which are relatively labour intensive), followed by cotton and textiles which are export-oriented sectors (Table 6). Prices decline across the board in the longer run (Table 7), partially explaining the gains in household consumption.

Table 6 Sectoral impacts of 4 % increase in public infrast. investment-to-GDP ratio (international borrowing), percentage change wrt base scenario

	Food crop	Min. crop	Agr prod	Cotton	Livestock	Manufacturing	Energy	Textiles	Construction	T&C	Priv serv	Pub serv
Gross output												
First period	−0.11	−0.03	−0.11	−0.36	−0.03	−0.06	−0.15	−0.37	0.79	−0.02	0.01	−0.07
Short run	0.39	0.49	0.45	0.35	0.47	0.61	0.32	0.34	1.32	0.38	0.31	−0.05
Long run	1.44	1.44	1.54	1.88	1.54	1.94	1.25	1.86	2.22	1.11	0.91	0.11
Investment												
First period		0.73	0.67	0.24		0.97	0.43	0.32		1.18	1.20	
Short run		1.36	1.40	1.50		1.81	1.23	1.54		2.09	2.06	
Long run		2.17	2.31	2.87		2.92	2.16	2.87		3.53	3.44	
Exports												
First period	−0.74	−0.43	−0.57	−0.38	−0.81	−0.42		−0.60		−0.39	−0.50	−0.57
Short run	0.08	0.44	0.30	0.37	0.22	0.31		0.17		0.13	−0.34	−1.25
Long run	2.31	2.05	2.18	2.04	2.91	1.87		1.91		1.12	0.18	−1.94
Imports												
First period	1.19	0.85	1.13	−0.31	1.53	0.92	0.41	0.69			0.91	0.87
Short run	1.05	0.60	0.84	0.28	0.98	1.41	0.67	1.11			1.47	2.17
Long run	−0.32	0.11	−0.14	1.44	−1.15	2.14	1.05	1.59			2.21	3.88
Domestic demand												
First period	−0.10	−0.01	−0.01	−0.36	−0.03	0.02	−0.15	−0.17	0.79	0.04	0.01	−0.07
Short run	0.40	0.50	0.48	0.34	0.47	0.68	0.32	0.48	1.32	0.43	0.31	−0.04
Long run	1.43	1.40	1.40	1.84	1.54	1.96	1.25	1.81	2.22	1.11	0.91	0.13
Consumption												
First period		0.12	0.07	0.25	−0.01	0.18	0.18	0.12	−0.21	0.11	0.09	0.10
Short run		0.55	0.51	0.58	0.48	0.50	0.52	0.46	0.18	0.46	0.35	0.17
Long run		1.25	1.30	1.10	1.51	1.02	1.07	1.07	1.05	1.04	0.79	0.36
Demand for intermediate use												
First period	−0.08	−0.05	−0.07	−0.36	−0.06	0.13	−0.06	−0.33	0.18	−0.06	−0.06	−0.07
Short run	0.41	0.43	0.44	0.33	0.47	0.65	0.37	0.34	0.57	0.37	0.40	0.38
Long run	1.40	1.38	1.46	1.83	1.54	1.63	1.22	1.76	1.30	1.24	1.31	1.31

Source: Authors' computation based on simulation results

T&C transport and communications, food crop, minor crop, livestock and agr prod are constrained sectors

Table 7 Price impact of 4 % increase in public infrastructure investment-to-GDP ratio (international borrowing), percentage change wrt base scenario

	Food crops	Minor crops	Agri processing	Cotton	Livestock	Manufacturing	Energy	Textiles	Construction	T&C	Priv. serv.	Pub. serv.
Price of gross output												
First period	0.14	−0.21	−15.12	−12.4	0.39	−15.86	−34.38	5.17	0.46	−0.27	0.68	−6.12
Short run	−0.02	−0.38	−15.25	−12.4	0.13	−15.89	−34.41	5.13	0.35	−0.33	0.76	−5.78
Long run	−0.60	−0.70	−15.58	−12.5	−0.67	−15.98	−34.50	5.02	−0.23	−0.46	0.79	−5.38
Price of domestic goods												
First period	0.32	0.21	0.28	0.01	0.39	0.22	0.14	0.22	0.67	0.22	0.26	0.25
Short run	0.16	0.03	0.09	−0.02	0.13	0.18	0.09	0.16	0.56	0.15	0.33	0.61
Long run	−0.43	−0.32	−0.38	−0.10	−0.67	0.04	−0.05	−0.05	−0.02	0.00	0.37	1.05
Price of composite goods												
First period	0.32	0.20	0.27	0.01	0.39	0.12	0.11	0.20	0.67	0.22	0.25	0.23
Short run	0.16	0.03	0.09	−0.02	0.12	0.10	0.07	0.15	0.56	0.15	0.32	0.56
Long run	−0.43	−0.30	−0.37	−0.09	−0.66	0.02	−0.04	−0.05	−0.02	0.00	0.35	0.96
Shadow price of capital												
First period		0.54	0.53	0.44		0.60	0.48	0.46		0.64	0.65	
Short run		0.54	0.55	0.59		0.60	0.53	0.59		0.64	0.64	
Long run		0.16	0.16	0.20		0.18	0.16	0.19		0.21	0.21	

Source: Authors' computation based on simulation results

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Under a policy experiment of infrastructure financed through international borrowing, poverty reduction can be observed from the very beginning (Table 11), with higher wages contributing the most to poverty reduction, followed by increased self-employment incomes (Table 12).

Poverty is lower in the long run among both household types, but the relative improvements in the poverty headcount are higher among constrained households (Table 13). The provincial poverty incidence results show that poverty reductions are greatest in the Punjab and Sindh provinces (Table 14). The international borrowing scenario is redistributive, with inequality falling throughout the time horizon (Table 15).

Unlike the previous simulation, financing the 4 % increase in the public infrastructure investment-to-GDP ratio by an increase in taxes strains real GDP growth in the first period (−0.06 %). However, growth recovers in the short-run (within 5 years) and is 1 % higher than the baseline scenario in the longer-run (Table 8), but below the rates predicted for the international borrowing scenario along the whole simulation timespan. Total consumption follows a similar pattern: the increased tax burden causes total household consumption to decline by 0.1 % in the first period, but is 0.94 % higher in the longer run. As in the previous simulation, total household consumption is redistributed somewhat, with increased taxes implying greater gains for constrained households (1.2 %) than for non-constrained households (0.2 %), which have access to savings instruments. This is primarily due to an increased incidence of tax on non-constrained households who own enterprises facing the distortionary production tax. This tax mostly affects large manufacturing firms, which are mostly in food processing-, textiles- and construction-related industries.

The main increase in overall investment comes from public investment, which is 5 % higher in the longer run. There are also positive knock-on effects on private investment, which increases by 2.3 %, providing evidence of a crowding-in effect.[11] In the private sector, investment by non-constrained firms is 2.7 % higher in the long run. While constrained firms also gain in the short run and beyond, their investment declines by 0.27 % in the first period. This can be attributed to the lagged transmission of the increase in overall pool of savings to be used for investments by constrained firms, which in the model are assumed to be financed by own retained earnings.[12]

The price of capital and labour move in opposite directions whereby the former increases in the short run but declines in the long run, in turn resulting in greater capital formation.[13] This may be attributed to the increased tax burden which

[11] It is important to note that private investment is higher despite a production tax due to complementarities in public and private investment. However, in the short term there is a negative impact on private investment at the disaggregated level and a null effect on the capital stock.

[12] The positive externality of public investment in terms of expansion in private capital stocks is around 1.7 % in the long run.

[13] The complementarity of private capital linked to the public capital rises and this produces an implicit surplus of private capital in the long run, thus pushing the price or returns to private capital downwards. Also, labour becomes relatively more rare, pushing wages upwards.

Table 8 Aggregate impacts of 4 % increase in public infrastructure investment-to-GDP ratio (tax financing), percentage change wrt base scenario

Variable	First period	Short run	Long run[a]
Real GDP	−0.06	0.33	1.01
Wage rate	−0.32	0.51	1.86
Price of capital goods	0.12	0.14	−0.02
Rental rate of capital, constrained households	0.02	1.02	1.24
Total household consumption	−0.11	0.25	0.94
Constrained	−0.15	0.38	1.19
Non-constrained	−0.09	−0.04	0.18
Total Investment	1.29	1.99	3.07
Public	3.81	4.19	5.07
Private	0.29	1.11	2.27
Constrained	−0.27	0.24	1.21
Non-constrained	0.54	1.50	2.74
Total capital stock		0.71	2.53
Public		1.76	4.47
Private		0.26	1.69
Constrained		−0.02	0.84
Non-constrained		0.40	2.11
Total exports	−0.19	0.45	1.88
Total imports	0.37	0.89	1.58
Real exchange rate	0.03	0.01	0.12
Foreign savings as % of GDP	−2.68	−2.70	−2.82
Total income of constrained households	−0.15	0.38	1.19
Labour income	−0.32	0.51	1.86
Capital income	0.02	1.00	2.09
Government revenues	1.18	1.62	2.26
Increase in production tax rate (%)	3.43	3.03	1.73

Source: Authors' computation based on simulation results
[a]In case of CGE results long run represents a 60 year period

reduces retained earnings in the short run, although the increase in public investment afforded by increased taxation in the longer run leads to greater capital formation and ultimately economic growth through a multiplier effect. The wage rate slumps by 0.32 % in the first period, recovers in the short run and is nearly 2 % higher in the longer run. The differences in the increased usage of production factors can also be attributed to the distortionary effects of the increased production tax.

The external balance, measured as foreign savings as a ratio of GDP, remains in the vicinity of 3 %. The key changes are seen in the trade account. Despite real exchange rate depreciation, exports decline sooner due to supply side losses resulting from the higher tax burden. Following a 0.2 % decline in the first period, exports recover by 2 % in the long run. The trade deficit narrows somewhat in the long run (by 2.6 %) because imports grow more slowly.

The overall increases in household and corporate incomes, private consumption, value added in the manufacturing sector and imports, cause government revenues to

increase by 1.2 % in the first period and by 2.3 % in the long run. Income, consumption, value added and imports are all taxed at various stages and thus contribute to government revenues.

It is important to look into the sectoral impacts of changes in GDP components (Table 9), as gross output in most sectors decreases in the first period, but recovers in all sectors in the long run. Expanded output also contributes to declining prices in the long run. Most of this follows the underlying trend of lower consumption (due to the increased tax burden) except in the manufacturing and construction sectors. Total investment increases in all sectors in the first period, except in the energy sector where it recovers in the short run.

Exports increase in most sectors in the first period, except in non-textile manufactured items, processed food and cotton, which see a decline in exports. Exports of non-textile manufactured items also remain below their baseline value in the short run, but do grow by 1.5 % in the long run. The negative growth in exports of public services can be explained by the fall in transport and logistics services provided by Pakistan to other countries seeking transit, in particular foreign governments seeking to access Afghanistan through Pakistan.[14]

Domestic prices decline in most sectors except for the cotton, non-textile manufacturing and energy sectors (Table 10). Since these types of goods make up a relatively larger share of the household budget among the poor, lower prices have a redistributive effect, reducing inequality.

We now look at the poverty impacts of tax-financed public infrastructure. Unlike the previous simulation, this production tax is distortionary, adversely affecting the poverty headcount in the first period through reduced consumption and income. Increased infrastructure eventually helps expand supply and lower prices, restoring consumption and investment growth and thereby improving poverty levels. In Table 11, we can see that poverty is 0.3 % lower in the long run (20 years in our microsimulation). The change in poverty is statistically significant at the 95 % confidence level.[15]

We also see in Table 12 that increased wages and proceeds from self-employment are the main drivers of poverty reduction. Constrained households see a greater reduction in their poverty levels over the long run (Table 13), as partially reflected by the higher increase in real consumption among

[14] Other items are counted under public sector services exports, transport and logistics services dominate.

[15] CGE results (regarding quantitative variables) are provided to the micro model in productive worker terms (it then takes into account the change in population, labour and technology). This approach allows us, though not fully satisfactorily, to leave the original micro-data unchanged. Then, changes in savings are introduced into the micro model by plugging in results obtained in the CGE model. Also, the macro model did not distinguish workers by skill and sector (full mobility across sectors), so the micro framework did not model the evolution in education/skills and labour mobility. Finally, for simplicity and lack of satisfactory information in the household survey, we made the hypothesis that capital endowments are fixed.

Table 9 Sectoral impacts of 4 % increase in public infrastructure investment-to-GDP ratio (tax financing), percentage change wrt base scenario

	Food crops	Minor crops	Agri Proc	Cotton	Livestock	Manufacturing	Energy	Textiles	Construction	T&C	Private services	Public services
Gross output												
First period	−0.24	0.01	−0.26	−0.26	−0.07	−0.43	−0.63	0.10	0.55	−0.09	−0.03	−0.10
Short run	0.21	0.49	0.24	0.43	0.36	0.18	−0.19	0.77	1.06	0.28	0.25	−0.11
Long run	1.22	1.35	1.32	1.89	1.34	1.61	0.89	2.06	1.98	0.98	0.82	0.05
Investment												
First period		0.58	0.10	0.62		0.06	−0.87	1.40		0.77	0.70	
Short run		1.15	0.97	1.58		1.21	0.46	1.96		1.66	1.58	
Long run		1.95	2.00	2.83		2.57	1.74	2.96		3.13	3.04	
Exports												
First period	0.05	0.44	−0.41	−0.69	0.18	−0.79		0.22		0.06	0.43	0.07
Short run	0.60	1.17	0.32	0.11	0.90	−0.15		0.93		0.47	0.44	−0.72
Long run	2.40	2.43	2.08	1.87	3.05	1.53		2.35		1.28	0.61	−1.59
Imports												
First period	−0.83	−0.92	0.14	0.89	−0.57	0.55	0.99	−0.42			−0.82	−0.39
Short run	−0.59	−1.00	0.04	1.29	−0.69	1.08	1.26	0.03			−0.09	1.03
Long run	−1.16	−0.97	−0.68	1.94	−2.01	1.83	1.30	0.76			1.18	3.06
Domestic demand												
First period	−0.25	−0.02	−0.22	−0.16	−0.07	−0.34	−0.63	0.01	0.55	−0.12	−0.03	−0.10
Short run	0.20	0.44	0.22	0.50	0.36	0.26	−0.19	0.63	1.06	0.24	0.25	−0.11
Long run	1.20	1.28	1.15	1.89	1.34	1.63	0.89	1.81	1.98	0.93	0.82	0.07
Consumption												
First period	−0.25	−0.07	−0.21	−0.14	−0.07	0.08	−0.27	−0.02	0.55	−0.12	−0.06	−0.10
Short run	0.19	0.36	0.22	0.53	0.35	0.65	0.13	0.59	1.06	0.24	0.23	0.03
Long run	1.17	1.14	1.08	1.89	1.30	1.72	0.98	1.75	1.98	0.93	0.83	0.33

Source: Authors' computation based on simulation results

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Table 10 Price impacts of 4 % increase in public infrastructure investment-to-GDP ratio (tax financing), percentage change wrt base scenario

	Food crops	Minor crops	Agri processing	Cotton	Livestock	Manufacturing	Energy	Textiles	Construction	T&C	Private services	Public services
Price of gross output												
First period	−0.32	−0.62	−15.50	−12.46	−0.12	−16.13	−34.73	5.07	0.01	−0.54	0.21	−6.54
Short run	−0.37	−0.75	−16.57	−12.48	−0.26	−16.15	−34.70	5.04	0.01	−0.56	0.34	−6.16
Long run	−0.75	−0.93	−16.76	−12.53	−0.84	−16.17	−34.67	4.94	−0.37	−0.60	0.53	−5.63
Price of domestic good												
First period	−0.15	−0.23	0.09	0.26	−0.12	0.22	0.41	−0.11	0.22	−0.09	−0.23	−0.09
Short run	−0.20	−0.36	−0.05	0.20	−0.26	0.20	0.36	−0.15	0.23	−0.11	−0.10	0.31
Long run	−0.59	−0.56	−0.45	0.01	−0.84	0.05	0.10	−0.26	−0.16	−0.17	0.10	0.84
Price of composite good												
First period	−0.09	−0.30	−0.39	−0.36	−0.03	−0.44	−0.54	−0.23	−0.10	−0.32	−0.32	−0.28
Short run	0.86	0.43	0.41	0.42	0.95	0.40	0.37	0.45	0.84	0.45	0.45	0.57
Long run	1.44	1.46	1.43	1.45	1.33	1.44	1.44	1.44	1.46	1.59	1.59	1.78
Shadow price of capital												
First period		0.24	0.14	0.25		0.13	−0.07	0.42		0.28	0.27	
Short run		0.31	0.30	0.38		0.35	0.26	0.41		0.39	0.38	
Long run		0.06	0.07	0.10		0.10	0.08	0.08		0.12	0.11	

Source: Authors' computation based on simulation results

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Table 11 Impact of 4 % increase in public infrastructure investment-to-GDP ratio on poverty headcount, as % from the base year

Simulation	1 year	5 years	20 years
International borrowing	−0.02	−0.18	−0.40[a]
Tax financing	0.012	−0.09	−0.31[a]

Source: Authors' calculation based on simulation results

[a]Indicates that the variation in comparison with the base year scenario is statistically different from zero (at 95 % confidence interval)

constrained households.[16] One could also argue on the income side (at the macro level) that the capital income of constrained households has increased relatively more than labour income. In the longer run, capital income has a greater multiplier impact on components of economic growth, implying that households are able to increase their retained savings for future consumption (or investment).[17] A related point is that prices in the most important consumption categories for constrained households decreased faster (or increased less) and their main sources of incomes increased faster (or decreased less) than non-constrained households. In terms of provincial poverty levels (Table 14), we observe a similar progress in poverty reduction as observed in the previous simulation, with Punjab, followed by Sindh, showing the largest improvement. One way to explain this is that Punjab has the largest number of constrained households which, as stated above, are simulated as having a larger increase in real consumption. The Gini inequality coefficient is higher in the first year due to the distortionary tax, then improves due to wage increases in later periods (Table 15). We may conclude that infrastructure financing through increasing production taxes is more painful in the very short term.

Finally, with respect to the contribution of the own-consumption component to poverty reductions, we found no effect. This is an expected quantitative result when the changes in self-production and/or consumer prices are sufficiently negligible. In our case it seems to be a combination of both: three of four provinces have seen reductions in self-production stocks (explained below), in addition to the small magnitude of the price change.

The report by the Sustainable Development Policy Institute entitled *Food Insecurity in Pakistan 2009* highlights that food security (including availability aspects) has deteriorated in 81 out of 131 districts of Pakistan.[18] Around 49 % of the

[16] It is important to note that we have used the classification of constrained and non-constrained households as we are interested in distinctly observing poverty and inequality effects on households with access to capital markets versus those without such access. This hypothesis is particularly pertinent in a developing country's context, where a lack of or barriers to credit access still represents a major obstacle in economic development. The constrained versus non-constrained distinction mirrors the difference in investment and savings patterns and finally results in differentiated impacts of public infrastructure investment on household welfare. In the longer term, access to financial services is expected to smooth consumption patterns.

[17] However labor income is a greater share of the overall incomes of non-constrained households.

[18] In 2003, food security conditions were deemed inadequate in 45 out of 120 districts.

Table 12 Long-run (20 years) impact of different factors on poverty headcount, as % from the base year

Variable	International borrowing	Tax financing
Wage employment	−0.25	−0.24
Self-employment	−0.20	−0.11
Consumer prices	0.06	0.04
Own-consumption	0.00	0.00
Residual	−0.01	−0.00

Source: Authors' calculation based on simulation results

Table 13 Change in poverty headcount by household type in the long-run (20 years), as % from the base year

Variable	International borrowing	Tax financing
Constrained	−0.42	−0.34
Non-constrained	−0.38	−0.27

Source: Authors' calculation based on simulation results

Table 14 Long run (20 years) poverty reduction by province, as % from the base year

Type of households	International borrowing	Tax financing
Punjab	−0.43	−0.33
Sindh	−0.40	−0.30
Khyber Pakhtunkwa	−0.35	−0.26
Balochistan	−0.33	−0.25

Source: Authors' calculation based on simulation results

Table 15 Changes in Gini inequality coefficient, as % from the base year

Simulations	1 year	5 years	20 years
International borrowing	−0.03	−0.07	−0.12
Tax financing	0.02	−0.04	−0.11

Source: Authors' calculation based on simulation results

Pakistani population does not have access to sufficient food for an active living. There is evidence of inter and intra-provincial disparities. The report also explains that, between 2003 and 2009, wheat production rose by 6 % in surplus-producing districts, but the percentage of surplus wheat available (which is usually exported) declined from 28.3 % in 2003 to 17.5 % in 2009 implying that the majority of provinces are now relying on external food sources. The above-mentioned phenomenon is also supported by the observation that wheat consumption has continued to decline because rising global crop prices effectively reduce purchasing power for wheat. In 2009 alone, wheat consumption declined by 10 %.

The report goes on to discuss at least two important implications of the high food prices and declining returns to farm activities with respect to the reduction in own-consumption. First, rising crop prices mean that the poorest farming households have squeezed their own-consumption stocks and traded them for short term monetary gains. Second (and related to first point) the coping strategy in both urban and rural areas is to meet caloric requirements from less preferred and less expensive food.

Finally, it is important to mention that in a quantitative exercise such as this one the direction of change in key macro and microeconomic variables is more important that the magnitude. While both simulations point towards greater prospects for growth and poverty reduction due to increased infrastructure investment, the choice between taxation and international financing (borrowing) will also involve difficult political considerations.

Conclusion

In this chapter we use a dynamic CGE model linked with a microsimulation model to estimate the macro–micro impact of public infrastructure investment. In the model we have made a distinction between constrained households and firms (who are constrained by their lack of access to credit and savings instruments) and non-constrained households and firms who are fully integrated into the open economy and have access to both domestic and international capital.

Two approaches to public investment are considered in our simulations. In the first case, production taxes finance the additional public infrastructure investment and foreign financing (borrowing) provides resources in the second case. Our quantitative results reveal that public infrastructure investments have the same direction of impact whether funded by taxation or international financing (borrowing), particularly when looking at the macroeconomic gains and poverty reduction. However, in the very short run (the first period, i.e., year 1), tax financing puts a strain on output in the industrial sector (because this sector faces the largest burden of taxes, particularly of production taxes) and thus reduces economic growth in the first period. However, financing from international borrowing has a certain Dutch disease-like impact in the first period, as indicated by a decline in exports. Most of our results, particularly in the real sector of the economy, are in line with earlier work by Khan and Sasaki (2001).

Real GDP grew in the longer run by 1.01 and 1.29 %, respectively under tax and international financing. Household consumption in these scenarios increased by 0.94 and 1.2 % over this time frame. In the tax financing scenario, long run increases in production make up for reduced consumption and investment in the first period. The poverty headcount ratio respectively improved by 0.31 and 0.4 % under tax financing and international borrowing. Inequality is somewhat lower in the long run in both cases.

Like with any other quantitative approach, our results should be interpreted in consideration of model limitations. Furthermore the impact of public investment not only depends on the size of investment but the efficiency with which this invested sum is utilized and absorbed. It also depends on which sectors are targeted by the government interventions. It is important not to compete with the private sector and instead only focus on areas characterized by market failure. In raising revenues through taxation, it will be important to see which sectors are taxed and in which manner(s). Achieving an increase in direct taxes will most easily be realized

if the government takes measures to remove barriers to entry and exit in the market and to remove state-designed procedures which distort consumption and production decisions.

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Conclusion

John Cockburn, Yazid Dissou, Jean-Yves Duclos, and Luca Tiberti

The structural adjustment policies that were followed during the 1980s and 1990s have produced mixed outcomes, particularly in terms of poverty and inequality reductions. This has spurred, over the years, the international community to ask whether different combinations of public policies could have better development impacts. In particular, it is now often argued that infrastructure development can serve not only as an important source of fiscal stimulus in the short run, but also as a tool for encouraging growth in the longer run and an avenue for generating broad-based economic development. Such broad-based development is especially important since inclusiveness of growth features as an overriding objective of the current development paradigm.

It is within that context that this book seeks to understand better the role of infrastructure in fostering and broadening development. This involves considering how infrastructure investment impacts aggregate production, sectoral allocation of production, economic growth, household welfare and poverty and inequality. An encompassing and original analytical approach is used that combines the strengths of general equilibrium analysis – which is essential for taking into account the economy-wide interactions across production and consumption activities that are spurred by infrastructure policies – and the strengths of micro economic analysis – which is needed to take into account the micro level effects of major economic policies, especially in terms of household behavior, household welfare, inequality and poverty.

The book starts by presenting theoretical models of human capital and infrastructure development within an endogenous growth framework, followed by a review of some of the empirical findings on the effects of infrastructure and

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education on growth and poverty, with a particular emphasis on developing countries. Empirical evidence is then provided on the potential growth and welfare effects of increasing public investment in infrastructure in three Asian countries, the Philippines, China and Pakistan.

To provide such evidence, an intertemporal dynamic computable general equilibrium model is combined with a microsimulation model and then applied to the three countries. The total capital stock is distinguished between public and private. Consistent with the reality of developing countries, in which most households do not have access to formal credit markets, credit-constrained and credit-unconstrained households and firms are also distinguished. Unconstrained agents are characterized by their ability to take decisions on savings and investment behavior that are based partly on their expectations of the future. This is an important feature of the book's analytical framework: it recognizes that anticipations of the future (such as anticipations of the effects of infrastructure on future levels of development) can have an impact on current behavior and welfare.

Although the exact infrastructure investment amounts are country-specific, the models and types of financing mechanisms considered are common to all three countries. The differences in the macro- and micro-economic outcomes are then essentially a matter of differences in the countries' sectoral economic structure, in the distribution of assets and in production and consumption behavior.

Aggregate and sectoral production outcomes, as well as poverty and distributive impacts, are analyzed in the short, medium and long runs. These impacts are contrasted across two alternative financing mechanisms, namely distortionary (i.e., through a production tax) and non-distortionary (through international borrowing) means of financing. The overall effects of an increase in public investments in infrastructure depend on a trade-off between the increased productivity generated by such investments and the distortionary effects of taxes. These effects also depend on the productive structure of the economy considered. The structure of the economy is also important when it comes to assessing the impact on household welfare: that impact is most dependent on the initial distribution of factor endowments (and thus on the distribution of income sources) and on household preferences.

Comparisons across the three countries provide new and interesting insights. All of the evidence unambiguously suggests that increasing investment in public capital positively impacts economic growth through higher capital accumulation and greater productive capacity of private firms, both in the short and, especially, long runs. An important finding is therefore that public infrastructure investment promotes stronger growth and that the positive supply-side effects on private sector productivity increase over time. Because of this, the growth effect of public capital investment is larger in the longer term.

Initial crowding-out effects of a production tax on private sector investment are observed in all three economies, however investing in infrastructure offsets this effect over time by crowding in private investment. Public sector investment in infrastructure also generally increases aggregate household consumption, with the exception of the first-year impact in Pakistan in the specific case of financing through a production tax.

The book's results further suggest that infrastructure investment financed by international borrowing generates larger beneficial effects in Pakistan and in the Philippines, while production tax financing should be preferred in China. This result comes despite the fact that financing through international borrowing generates what is known as a Dutch disease effect of appreciation of the real exchange rate. While for Pakistan some symptoms of this disease are visible only soon after the implementation of the infrastructure policy, the Chinese and Philippine economies display signs over a longer time period. In all cases, the positive productivity effects of public capital are crucial in mitigating the Dutch disease effects on production and welfare.

The initial level of economic and infrastructure development also matters considerably. Public infrastructure investment appears to be associated with stronger long-run output and a larger crowding-in effect on the private sector in more developed economies with greater levels of private capital. This is seen inter alia when the long-term results of China are compared to those of the Philippines, two countries in which the effects of a comparable increase in public investments were simulated.

An important finding of this book's case studies is that certain industries are more sensitive to infrastructure policy than others. This is valuable policy information: some sorts of sectoral performance are more likely than others to be enhanced through investment in infrastructure. The main reason for this is that the private sector productivity impact of public capital is generally not evenly distributed across industries. Efficiency would dictate that policy should favor public infrastructure investment that is complementary to the capital of those economic sectors whose marginal product is highest in the long run.

The magnitude of the impact of public infrastructure can also differ according to the choice of financing mechanism. Public capital investment decisions should therefore take into account the type of financing mechanism associated with such decisions. The case of the Philippines is informative in this regard: investment financed through foreign borrowing produces an almost equal long-run output effect across sectors, whereas production-tax financing does not produce any effect on some sectors. Perhaps even more importantly, some sectors can gain significantly under foreign borrowing: a country can become a net exporter in such sectors, while remaining a net importer in those same sectors under a production tax.

Infrastructure investment reduces poverty significantly in all three Asian countries considered in this book. Consistent with the macroeconomic effects, all three countries show a reduction in poverty over the medium to long run following an increase in public infrastructure investment. In the short run, that is 1 year after the implementation of the infrastructure increasing policy, the poverty results are ambiguous and depend on the type of financing scheme. Under a production tax, all countries exhibit an increase in poverty. In the Philippines, this is also true under foreign borrowing, mostly due to a significant increase in consumer prices. In general, the poverty effects are larger in the long run, in line with the increased aggregate economic activity over time.

The contribution to poverty reduction made by different sectors and income sources naturally depends on the socio-economic structure of the economy being considered. This being said, it is through increased wages that infrastructure development impacts poverty most, followed by the increased self-employment revenues. Important differences are observed within each country, with rural areas generally contributing the most to the reduction of national poverty. Furthermore, both credit-constrained and credit-unconstrained households benefit from increases in public infrastructure spending, again with some differences across the countries. In the long-run, Pakistan and China see poverty fall more rapidly among credit-constrained households, while the reverse is true in the Philippines. Overall, inequality is only modestly affected by public infrastructure spending.

The final lesson is twofold. First, the analysis of broad public infrastructure strategies does benefit from an analytical framework capable of modeling the economy-wide and the time-dependent effects of such strategies. Second, the distributive impact of infrastructure strategies is naturally context-dependent: it depends on the precise infrastructure investment mechanisms that are used by the states and on their interactions with the distribution of assets, the structure of household consumption and the structure of production behavior. Both of these features are important for understanding the dual impact of infrastructure investment through economy-wide and temporal effects on consumption, production and growth, and through micro-level impacts on welfare, poverty and inequality. It is our hope that this book will have demonstrated the applicability and the usefulness of such general equilibrium and microsimulation techniques for understanding the impact of public infrastructure investment policies.

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Infrastructure and Economic Growth in Asia

Public spending on infrastructure plays an important role in promoting economic growth and poverty alleviation. Empirical studies unequivocally show that under-investment in infrastructure limits economic growth. At the same time, numerous other studies have shown that investment in infrastructure can be an effective tool in fighting poverty reduction. In that context, the financing of infrastructure has been a critical element of most economic growth and poverty reduction strategies in developing countries since the start of this millennium. This book provides a comparative analysis of the aggregate and sectoral implications of higher spending on infrastructure in three very different Asian countries: China, Pakistan, and the Philippines. Particular attention is paid to the role of alternative financing mechanisms for increasing public infrastructure investment, namely distortionary and non-distortionary means of financing. The book will be of interest to scholars and policy-makers concerned with economic growth in developing countries.

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