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public infrastructure and
economic growth in Pakistan: a dynamic
CGE-microsimulation analysis

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

Abstract

The role of infrastructure in economic growth and welfare has been studied extensively across the literature over the past three decades. We use a dynamic CGE model linked to a microsimulation model to estimate the macro-micro impact of public infrastructure investment.

Two approaches to public investment are considered in our simulations. In the first, production taxes finance the additional public infrastructure investment and in the second, foreign borrowing provides resources. Our results reveal that public infrastructure investments have the same direction of impact whether funded by taxation or international borrowing, particularly when looking at macroeconomic gains and poverty reduction in the long run. However, in the very short run, tax financing puts a strain on output in the industrial sector and thus reduces economic growth in the short run. The financing from international borrowing has a Dutch disease-like impact in the short run, as indicated by a decline in exports.

Keywords: Infrastructure, Economic Growth, Poverty, Pakistan, Computable General Equilibrium

JEL classification: C68, E22, H54, I38

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1. 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). See World Bank (1994) for more on this. 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 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 4 discusses the model, data and parameterization. Section 5 explains our results and section 6 concludes with policy recommendations.

2. 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.

2.1. 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 complimented 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, Swaroop and Zhou (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 1950-1992 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, Vellutini and Warlters (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 (2006) 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, Perrault and Savard. (2009) show that foreign aid-funded infrastructure does produce Dutch Disease effects, but that the negative impacts differ by the type of investment. Economic growth attenuates these negative effects.

Dissou and Didic (2011) indicate 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.

2.2. 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, Iqbal and Siddiqui (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 five years. Pakistan faces severe power shortages of approximately 5000 megawatts 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 percent 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 (Ahmed, Sugiyarto and Shikha, 2010). Corruption in infrastructure projects has been estimated to be 10-15 percent 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 percent 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.

2.3. **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.

Complimentary 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, Dixon and Rimmer (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).

3. 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).

Table 1. Global infrastructure ranking, 2011-12

	Transport	Electricity & 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, 2011-12

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.

3.1. Road transport

For transportation, Pakistan relies heavily on roads which handle 96 percent¹ of total freight traffic.² The federal budget also exhibits a strong bias towards financing construction and

¹ Economic Survey of Pakistan, 2009-10.

² This section draws from our companion paper Haque, Pirzada and Ahmed (2011).

maintenance in the road sector. Since 1996, the total length of roads has increased by 13 percent to 259,618 kilometres in 2010, 179,290 of which were paved (referred to as high type). The national highways and motorways network constitutes 4.2 percent of the total road network and handles more than 85 percent 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 percent of inter-city traffic in the country. Around 60 percent 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 1000 km inclusive of bridges, flyovers, and interchanges have started. The NHA has also managed to increase its toll revenue by 36 percent over the past year.

Table 2. Road sector in Pakistan, 1997-2009

Year	High type		Low type		Total	
	Length	% Change	Length	% Change	Length	% Change
1997	126117	6.5	103478	3.6	229595	5.2
1998	133462	5.8	107423	2.5	240885	4.9
1999	137352	2.9	110140	-4.4	247484	2.7
2000	138200	0.6	105320	-2.4	240340	-2.9
2001	144652	4.7	102784	-3.7	249972	4.0
2002	148877	2.9	98943	-1.4	251661	0.7
2003	153255	2.9	97527	-2.2	252168	0.2
2004	158543	3.5	95373	-4.1	256070	1.5
2005	162841	2.7	91491	-5.6	258214	0.8
2006	167530	2.9	86370	-2.7	259021	0.3
2007	172827	3.2	84038	-1.1	259197	0.1
2008	175000	1.3	83140	-3.4	259038	-0.1
2009	177060	1.2	80328	2.5	260200	0.4

Source: Economic Survey of Pakistan, 2009-10

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 (2008) and Fan and Chan-Kang (2005). In the case of Pakistan, see Siddiqui (2008) and Chohan, Imran and Cheyne. (2011).

3.2. 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 percent to 10 percent of passengers and from 73 percent to 4 percent 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 3. Pakistan rail sector

Rail sector indicators	1991	2009	% change
Route travelled (km)	8775	7791	-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	34851	17259	-50.5

Source: Pakistan Railways

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 2008-09, earnings grew by 16 percent 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 2006-07 and over PKR 12 billion in 2007-08.³

3.3. Aviation

In 2007-08, Pakistan's 35 airports handled more than 14 million passengers and 318,652 million tons of cargo.⁴ 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 2005-06, 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 percent 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.

³ For detailed discussion of the growth and productivity effects of rail infrastructure investment, see Crafts (2011) and Banister and Thurstain-Goodwin (2010).

⁴ Civil Aviation Authority. <http://www.caapakistan.com.pk/>, access October 12th, 2012.

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 strongly 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.⁵

3.4. Energy

Pakistan has been facing significant energy shortages since 2008-09. 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. Electricity production (megawatts)

Year	Installed capacity (MW)	Generation (MW)
2001-02	17,799	8,265
2002-03	17,798	8,639
2003-04	19,257	9,235
2004-05	19,384	9,787
2005-06	19,450	10,705
2006-07	19,420	11,231
2007-08	19,420	10,943
2008-09	19,786	10,484
<i>Jul-Mar</i>		
2008-09	19,575	6,940
2009-10 (e)	19,650	7,517

Source: *Economic Survey 2009-10*

⁵ For discussion on how air transport infrastructure investment facilitates economic growth, see Hong, Chu and Wang (2011) and Marazzo, Scherre and Fernandes (2010). For Pakistan see Haque et al (2011).

Table 4 shows that electricity generation began to decline from 2006-07 onwards despite an increase in overall installed capacity during the same period. Fortunately, data for the last two years (shown only for July–March in these two years) shows a positive trend.

Despite frequent increases in electricity tariffs in the last two years, a wide gap still exists between generation cost and recovery. Before the increases in tariffs, this gap was estimated at around 30 percent. 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 2009.⁶

3.5. 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 percent 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 percent 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 to 40 percent of water supplies are lost through leakages in water distribution networks. Water treatment facilities are also limited.

⁶ 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).

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 percent 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.⁷

3.4. 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 percent in 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

⁷ 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).

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.

4. Model, Data and Parameterization

Our modeling strategy tries to track the effects of public investment in infrastructure over time at both the macro and micro levels. We use the intertemporal model presented in Dissou and Didic (2011) for a small open economy that produces and consumes tradable and non-tradable goods. Heterogeneity is introduced at two levels: households and firms, which are each further classified as constrained or non-constrained. Households or firms which are liquidity constrained and lack access to credit are termed constrained. These households are assumed to save a constant positive fraction of disposable income. Some households own constrained firms and use their own savings as capital. Both household types are assumed to not value leisure; their labour supply is thus inelastic and is assumed mobile across industries.

There are 12 production activities in the model and a representative firm is assumed to exist in each industry. Public capital defined by the aggregate public infrastructure stock is treated as an (pure public good) input in the production function and thus affects the productivity of private inputs. These productivity effects differ by industry. The model uses the aggregate capital stock as opposed to Perrault, Savard and Estache (2010), who try to disaggregate infrastructure into road, telecommunications, electricity and irrigation infrastructure.

Firms combine factor inputs to produce a composite output marketed domestically and abroad. Constant returns to scale are modelled for public and private factors and all variables are expressed in efficiency units of labour.

All markets are assumed to clear in every period. The labour market adjusts through wages and the goods market through prices of domestic good. Savings and investment are equal, with constrained firms only using savings of constrained households for investments and dividends

to non-constrained firms being net of investment. The total wealth of non-constrained households includes their stock of foreign assets.

The dynamic CGE model is calibrated to the benchmark data in the 2007-08 Pakistani social accounting matrix. We use the household budget survey from the same year for the microsimulation model. 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).

Our microsimulation process consists of four steps: estimation of whether households are constrained or non-constrained, estimation of revenues from wage and non-wage sectors, computation of price index and real per capita consumption, and estimation of poverty and inequality. This is done following the procedure proposed in Cockburn, Duclos and Tiberti. (2011) for Benin.

We start with the logit estimation of the probability of being a non-constrained household (i.e., having access to credit and savings instruments). The household socioeconomic characteristics used in this function include: region, province, existence of fixed household wages, whether residential property was rented out, occupational group, gender, age and age squared, and educational qualification of the household head.

Wage information is taken directly from micro-level data and if wages are missing then predicted values are estimated using a standard Heckman selection model. Incomes from self-employment in the sectors in the SAM include estimated revenues from production and whether destined for sale on the market or for own-consumption. Changes in self-employment income follow changes in value added in the CGE model. We estimate value added by multiplying volumes by prices then calculate the change in value added.

To calculate per capita consumption, we divide goods into 12 categories in the micro and macro models. The consumption values are converted into the time frame used to express poverty cut-offs. These values were then summed to arrive at base year aggregate (and then

per capita) consumption. A Cobb-Douglas utility function was then used to estimate price deflators in order to account for price differences across the simulation scenarios. The estimates of poverty and inequality are based on consumption-based measures.

Simulation design: we simulate a 4-percent increase in the public infrastructure investment-to-GDP ratio. This increase brings the public infrastructure investment-to-GDP ratio back to 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-percent increase in this ratio financed by either a) international borrowing or b) a production tax.⁸ We look at the short, medium and long term impacts in both of these policy experiments.⁹

5. Results

Financing the 4-percent increase in the public infrastructure investment-to-GDP ratio by an increase in taxes strains real GDP growth in the first period (-0.06 percent). However, growth recovers in the short run (within 5 years) and is 1 percent higher than the baseline scenario in the longer run (Table 5). Total consumption follows a similar pattern: the increased tax burden causes total household consumption to decline by 0.1 percent in the first period, but is 0.94 percent higher in the longer run. Total household consumption is redistributed somewhat, with increased taxes implying greater gains for constrained households (1.2 percent) than for non-constrained households (0.2 percent), 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-percent higher in the longer run. There are also positive knock-on effects on private investment, which increases by 2.3 percent, providing evidence of a crowding-in effect.¹⁰ In the private sector, investment by non-constrained firms is 2.7 percent higher in the long run. While constrained

⁸ 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.

⁹ 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.

¹⁰ 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.

firms also gain in the short run and beyond, their investment declines by 0.27 percent 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.¹¹

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.¹² This may be attributed to the increased tax burden which 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 percent in the first period, recovers in the short run and is nearly 2 percent 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 percent. 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 percent decline in the first period, exports recover by 2 percent in the long run. The trade deficit narrows somewhat in the long run (by 2.6 percent) 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 percent in the first period and by 2.3 percent 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 (

¹¹ The positive externality of public investment in terms of expansion in private capital stocks is around 1.7 percent in the long run.

¹² 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 6), 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 by the manufacturing and construction sectors. Total investment increased, except in the energy sector where it recovered in the short run.

Exports increase in most sectors in the first period, except for non-textile manufactured items, processed food and cotton, which see declining exports. Exports of non-textile manufactured items also decline in the short run, but do grow by 1.5 percent 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.¹³

Domestic prices decline in most sectors except for the cotton, non-textile manufacturing and energy sectors (Table 7). Since these types of goods are 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. 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

¹³ Other items are counted under public sector services exports, transport and logistics services dominate.

Table 11, we can see that poverty is 0.3 percent lower in the long run (20 years in our microsimulation). The change in poverty is statistically significant at the 95-percent confidence level.¹⁴

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 consumption among constrained households.¹⁵ 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).¹⁶ 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 that progress in poverty reduction was greatest in Punjab, followed by Sindh. 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 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).

¹⁴ It is important to explain here how factor endowments are updated in the model. 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 allowed 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.

¹⁵ 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.

¹⁶ However labor income is a greater share of the overall incomes of non-constrained households.

The second counterfactual scenario that we study in this paper is the 4-percent increase in the public infrastructure investment-to-GDP ratio, financed by international borrowing. In this case (unlike the previous simulation), real GDP growth is higher right from the very first period because foreign savings finance the borrowing used to increase investment. The overall long-run impact on growth (1.3 percent) is greater than a tax-financed increase in the public infrastructure investment-to-GDP ratio. Total investment and household consumption are both higher in the long run, respectively by 3.4 and 1.2 percent (

Table 8). As in the previous simulation, infrastructure investment appears to have redistributive effects, given that the rise in consumption is relatively higher among 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 percent) and private (+2 percent) capital stocks. The capital stock increases by relatively more among non-constrained firms due to their access to financial services.

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 percent and imports increase by 0.84 percent. In the long run, both exports and imports increase because an improved availability of investment funds and improved infrastructure both improve supply side conditions. The increase in the international borrowing-to-GDP ratio tapers off (declining by 0.09 percent 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 9). Prices decline across the board in the longer run (Table 10), partially explaining the gains in household consumption.

Unlike the previous simulation, under a policy experiment of infrastructure financed through international borrowing, poverty reduction can be observed from the very beginning. Gains in the first period are higher than with tax-financed infrastructure investment. Higher wages contributed most to poverty reduction, followed by increased self-employment income.

Poverty is lower in the long run among both household types, but the relative improvements in the poverty headcount are higher than among constrained households. The provincial poverty incidence results are similar to earlier simulations, where poverty reductions are greatest in the Punjab and Sindh provinces. The international borrowing scenario is redistributive, with inequality falling throughout the time horizon. We may conclude that infrastructure financing

through international borrowing is less painful in the very short term – something not observed in the earlier simulation.

At this point we should also discuss why own-consumption was not found to be linked to poverty reductions in either simulation. This is an expected quantitative result when the changes in own-consumption 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 own-consumption 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.¹⁷ Around 49 percent of the 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 percent in surplus-producing districts, but the percentage of surplus wheat available (which is usually exported) declined from 28.3 percent in 2003 to 17.5 percent 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 percent.

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 than 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.

¹⁷ In 2003, food security conditions were deemed inadequate in 45 out of 120 districts.

6. Conclusion

In this paper 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 percent, respectively under tax and international financing. Household consumption in these scenarios increased by 0.94 and 1.2 percent 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 percent 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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ANNEX I - Tables

Table 5. 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 ¹⁸
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

¹⁸ In case of CGE results long run represents a 60 year period.

Table 6. Sectoral 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
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

*T&C = transport and communications

Table 7.

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	

*T&C = transport and communications

Table 8. 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

Table 9. 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	Live-stock	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

Table 10:

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	

Table 11.

Impact of 4% increase in public infrastructure investment-to-GDP ratio on poverty headcount

Simulation	1 year	5 years	20 years
Tax financing	0.0124	-0.0909	-0.3105*
International borrowing	-0.0229	-0.1833	-0.4012*

* indicates that the variation in comparison with the base year scenario is statistically different from zero (at 95% confidence interval)

Table 12. Long-run impact of household-specific variables on poverty headcount (%)

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

Table 13. Change in poverty headcount by household type (%)

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

Table 14. Long run poverty reduction by province (%)

Type of households	Tax financing	International borrowing
Punjab	-0.3332	-0.4298
Sindh	-0.3047	-0.4001
Khyber Pakhtunkwa	-0.2612	-0.3531
Balochistan	-0.2498	-0.3337

Table 15. Changes in Gini inequality coefficient

Simulations	1 year	5 years	20 years
Tax financing	0.0154	-0.0382	-0.1091
International borrowing	-0.0315	-0.0651	-0.1206