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Public Infrastructure and Economic Growth in Pakistan: A Dynamic CGE-microsimulation Analysis¹

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1. Introduction and Background

The role of infrastructure in impacting economic growth and welfare has been studied across literature intensely during the past 3 decades. Post World War II reconstruction gave us a model where governments used to invest in economies so that an enabling environment can be created for the private sector. This view led to infrastructure being viewed as a public good (or its variant) and for many countries its provision became the sole responsibility of the state.

Later however many experts realized that infrastructure needs to be divided into public works (mainly focusing on construction of infrastructure) and public service delivery (provision of utilities such as electricity and water). See World Bank (1994). While the former in the developing countries still remains a public sector domain the latter has seen the involvement of private sector (through unbundling of supply chain).

More recently in the wake of commodities price hike and the global financial crisis, developing countries have found it hard to sustain investment in infrastructure (Planning Commission 2011). This has led to closure of mega projects particularly in energy and water sectors, escalation of costs, time over-runs etc. Increasingly we see the governments now turning to alternate modes of financing, which included private sector participation e.g. public private partnership models and build operate and own models. However even these modes of financing have been found challenging as most developing countries have yet to come up with a legal and regulatory framework for such transactions. Until then infrastructure financing continues through foreign aid, raising taxes, 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. There are inter-regional and intra-regional inequalities as regards the access to even the basic infrastructure. This situation has forced people to migrate to cities in search of increased opportunities. Today Pakistan has the fastest urbanization rate in entire South Asia. This has in turn put pressures on the already stressed urban infrastructure.

In view of the above mentioned this paper makes an effort to study financing of public infrastructure through two alternate financing modes namely: international borrowing and production taxation. The next section provides a brief literature review on the subject followed by discussion on current state of infrastructure in Pakistan. Section 4 discusses details regarding model, data and parameterization. Section 5 explains our results and Section 6 concludes with policy recommendations.

2. Infrastructure and Economic Growth

We split the literature into two quantitative streams only for methodological ease. The first stream studies the impact of infrastructure on growth through econometric tools while the other uses computable general equilibrium models. We take the former first.

a. Global Evidence

The World Bank (1994) while providing important insight into infrastructure dynamics from an availability, efficiency and financing point of view, only narrowly defined infrastructure as public services which included electricity, energy, water; and public works which included mainly roads and other modes of transportation such as rail, port and aviation. Similarly seminal work by Aschauer (1989) showing significant impact of public capital on growth has contrary results when compared with Holtz-Eakin (1994). Later Aschauer (1998) suggested for Mexico that large public investments are not by themselves a sufficient condition for growth, but such investments have to be complimented with policies which address financing and utilization 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 equally important. Public expenditures on connectivity and ICT play an important role in facilitating growth processes. The connectivity between people and places has been shown to overcome urban-rural, gender and human capital disparities. Lall (2006) taking a pooled data set of Indian states shows that spending on transport and communication infrastructure are significant determinants of regional growth. There are positive externalities from investments by local and neighboring states. Earlier Devarajan et al. (1996) had found a negative and significant relationship between economic growth and ratio of transport and communications expenditure to total expenditure (in a sample of countries) and attributed this to the possibility that over investment in transport and communications makes such expenditures unproductive. Canning and Pedroni (2008) taking a panel of countries from 1950 – 1992 show that infrastructure does not tend to cause growth over longer run however there is variation across countries. Infrastructure is undersupplied in some countries and oversupplied in others.

In the same cross-country regressions tradition, Sanchez-Robles (1998) had used quantity of public infrastructure stock (measured through indices) instead of public expenditures on infrastructure and found positive and significant relationship. The author stressed on the efficiency of public investment in order to ensure optimal absorption. Accountability and civil

service reforms need to be put in place as part of a robust monitoring and evaluation, for projects funded through both 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 be because investments in infrastructure were made to relieve constraints and bottleneck (as and where they existed) rather than directly encourage growth.

In time-series studies, Nketiah-Amponsah (2006) show for Ghana that between 1970-2004 aggregate government expenditure had negative impact on economic growth. However disaggregated expenditures (in short run) on health and infrastructure had positive while education expenditures had negative impact on growth. The political economy variables such as governance, political instability were significant in explaining growth. Sahoo and Dash (2009) also show for India that stock of infrastructure positively contributes towards growth and there is a unidirectional causality for infrastructure development to output growth.

There are some CGE studies that investigate the economy-wide impact of public infrastructure. Rioja (2001) show in general equilibrium studies for Brazil, Mexico and Peru that they under invested in infrastructure during 1970s and 1980s. Simulations suggest that infrastructure can have positive impact on output, private investment and welfare.

Estache et al. (2009) show that foreign aid funded infrastructure does produce Dutch Disease effects but the negative impacts are dependent upon the type of investment. Furthermore the growth effects contribute to attenuate the negative effects.

Dissou and Didic (2011) indicate that 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.

b. Pakistan's Context

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

background studies that estimate the infrastructure deficit in Pakistan (Samad and Ahmed 2011).

World Bank (2007) reported that Pakistan's key infrastructure shortages lie in water, irrigation, power, and transport sectors. The country is amongst the most water-stressed in the world and the current water sector requires a maintenance cost of over \$7 billion across next five years. Pakistan faces severe power shortages of approximately 5000 megawatts and per capita energy consumption is amongst the lowest in the world which in turn retards industrial growth. The inefficiencies of rail, road, port and aviation sectors are now costing the economy over 4 percent of GDP.

While various governments with help from development partners have tried to pump capital in maintenance and incremental infrastructure, however the capacity to implement these programs remained weak. The lack of suitable human resources, poor planning and management skills and 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 due to declining economic growth it has become impossible to attract them back (Ahmed et al. 2010). Corruption in infrastructure projects has been estimated to be 10-15 percent of the project value. An average project takes 3 times as long and twice as much of the initially planned cost (Pasha 2011). This is attributed to: a) external verifications (National Accountability Bureau, Chief Minister's Inspection Teams, Parliamentary Committees etc.), b) Audit Procedures, c) local government procedures (mining, land acquisition, forest department etc.), d) law enforcement agencies and e) 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 due to excessive regulation this experience could not be replicated for other sectors such as energy where government continues to subsidize operations. See also SBP (2007). JBICI (2007) focuses on declining productivity of 45 percent of employed labour force, currently affiliated with agricultural sector, due to a dilapidated irrigation infrastructure. The report shows that access to irrigation infrastructure helps to keep the incidence of chronic poverty at lower levels. Furthermore improvement, lining and upgrading of water courses will help improve water efficiency.

Pakistan faces a major threat from climate change. The country has been regularly witnessing instances of floods, droughts and earthquakes. The Asian Development Bank, World Bank and One UN office jointly conducted the damage assessment for 2010 floods and reported an overall loss of PKR 855 billion. The reconstruction costs (which includes replenishment of lost infrastructure) range from 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.

c. Recent Issues

Infrastructure Affordability: Sustaining growth of infrastructure has been difficult for developing countries over the medium to long run. Lin (2011) identifies three reasons for slow down of infrastructure growth in China after 1978. These include: low government spending, decreased investment incentives of state enterprises and diminished ability of local government in mobilizing rural resources. Amongst the alternate ways to finance infrastructure, authors mention the role of domestic and foreign debt, taxes, fees and user charges, profits of state enterprises and labour services.

Complimentary Reforms: Dodonov et al. (2002) for transition countries (with special reference to Ukraine) 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 towards 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 a contractionary fiscal policy. Ramirez (2004) questions such stabilization policies in developing countries that disproportionately reduce spending on public infrastructure 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 that provide such important insights merit their mention here. These include: Giesecke et al. (2008) who study macroeconomic outcomes under alternative arrangements for financing of public infrastructure (see also Boccanfuso et al. 2012); Adam and Bevan (2006) look at the role of aid in public investment and possible Dutch disease effects (see also Levy 2007).

3. State of Infrastructure in Pakistan

Infrastructure provides the backbone for setting 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 indicates dismal picture for Pakistan in terms of its global ranking in infrastructure. While Pakistan has invested in public assets the efficiency with which these assets were governed has remained weak (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 many of which was actually leveraged through foreign aid. However given the rise in global commodity prices particularly input costs of construction sector, it became almost impossible for the government to afford the rising unit cost of infrastructure financing. In late 1990s it was realized that Pakistan in order just to keep the existing infrastructure maintained must deregulate, privatize and liberalize this sector for domestic and foreign private investment. These measures in absolute terms did increase the size of capital formation in transport and communication sectors.

a. Road Transport

For transportation, Pakistan relies heavily on roads which handle 96 percent⁵ of total freight traffic⁶. The federal budget also exhibits a strong bias towards financing building and maintenance of road sector. Since 1996, total road length has increased by 13 percent to 259,618 kilometers in 2010 out of which 179,290 kilometers were high type (paved). National

⁵ Economic Survey of Pakistan, 2009-10

⁶ This section draws from our companion paper Haque et al. (2011).

Highways and Motorways network constitute 4.2 percent of the total road network and handle more than 85 percent of Pakistan's total traffic. Majority of Pakistan's highways and motorways network is along North-South corridor with N-5 acting as the main artery and carrying 55 percent of country's inter-city traffic. Around 60 percent of the network is in poor conditions. This is mainly due to poor maintenance, vehicle overloading, inflated truck tires and 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 decline in low type roads (unpaved), since most low type roads are being converted to the 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	3.8	240885	4.9
1999	137352	2.9	110140	2.5	247484	2.7
2000	138200	0.6	105320	0	240340	0.3
2001	144652	4.7	102784	-4.4	249972	0.7
2002	148877	2.9	98943	-2.4	251661	0.7
2003	153255	2.9	97527	-3.7	252168	0.2
2004	158543	3.5	95373	-1.4	256070	1.5
2005	162841	2.7	91491	-2.2	258214	0.8
2006	167530	2.9	86370	-4.1	259021	0.3
2007	172827	3.2	84038	-2.8	259197	1.1
2008	175000	0.8	83140	-5.5	259038	-1.3
2009	177060	1.3	80328	-2.7	260200	0

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 in the infrastructure development side of roads. Roads are often left deliberately weak, susceptible to rapid deterioration, so that contracts can be given repeatedly to the same people.

For impact and transmission channels of how investment in road infrastructure leads to productivity, economic growth and poverty reduction Montolio and Solé-Ollé (2008) and Fan

and Chan-Kang (2005) may be seen. In case of Pakistan see Siddiqui (2008) and Chohan et al. (2011).

b. Rail Transport

Railways all over the world have an edge in long haul and mass scale transportation of both goods and passengers. In Pakistan, it was the primary mode of transport till 1970s. Since then its share has declined due to the shift in government's preference to road over rail transport. During 2005 to 2010, budgetary expenditure on railways was only PKR 45.5 billion whereas for national highways it stood at PKR 155 billion. Today its share of inland traffic has reduced from 41 percent to 10 percent for passenger and 73 percent to 4 percent for freight traffic.

Timely and safe delivery of goods to the North from the port, in the South, became a major issue after the shift in preferences of policy-makers. After the creation of National Logistic Cell (NLC) to clear the goods from Karachi port, Pakistan Railways (PR) has always found it difficult to regain its historical position. This has further pushed PR further backward. Looking at Table 3, we see a gradual decrease in not only the number of passengers and freight moved but also the length of track, 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 led to lowering of government revenues. There has also been a shortage of locomotives due to non procurement of spare parts. Much of the rolling stock destroyed during December 2007 riots is still to be repaired. This delay has been mainly due to reduction in PSDP disbursements and slow corporatization. Majority of the recently acquired engines from China are also facing maintenance issues which has lead to closure of various routes. Earnings are still low and are hardly enough to cover the cost of pays and pensions which equal PKR 14 billion and PKR 7 billion per annum, respectively. In 2008-09, earnings grew by 16 percent compared to the year before but since then they have worsened to pre-2004 levels. But despite improved

performance during the last decade, losses still remain high. In 2006-07, total loss was PKR 10 billion and in 2007-08, the loss was over PKR 12 billion.⁷

c. Aviation

As of 2007-08, Pakistan has 35 airports which handled more than 14 million passengers and 318,652 million tons of cargo during the same year⁸. Jinnah International Airport, Karachi is the busiest of all but Lahore and Islamabad airports also handle significant amount of both domestic and international traffic.

Compared to 2005-06, there has been a decrease in both cargo and passenger traffic. Total passenger traffic has declined by 0.4 million passengers whereas cargo handling decreased from 347,674 to 318,652 million tons. Most of this is attributed to reduction in domestic traffic due to poor economic situation, political instability, and law and order.

However, total number of airlines with operations in Pakistan has stayed the same with the number of domestic and international airlines equalling 28. But two of the Pakistani airlines namely Aero Asia and Royal Airlines are no longer in business. This is not only attributed to mismanagement but also to government's close association with state owned PIA, which denies competitive environment to other domestic airlines. PIA has a market share of 73 percent in passenger traffic and captures almost all the freight market in aviation sector. On international routes, there are frequent flights to UK and Middle Eastern countries. Demand on these routes mainly comes from Pakistani labor working abroad. However linkages with other countries remain largely infrequent and time consuming.

Due to extra checks on airlines flying via Pakistan and recent slowdown in aviation sector, international airlines largely stay hesitant in exploring Pakistani market. Currently there is no Pakistani airline flying to African and Latin American countries. South East Asia also stays untouched by Pakistani airlines except two direct flights per week to Malaysia. Connecting flights to these destinations are available but it takes much longer and brings greater uncertainty.

⁷For detailed discussion on implications for growth and productivity arising from investment in rail infrastructure, see Crafts (2011) and Banister and Thurstain-Goodwin (2010).

⁸Civil Aviation Authority

Domestic connectivity also faces many constraints in terms of inadequate airport handling and slow check-in procedures. This leads to lengthy flight delays which coupled with higher ticket prices relative to other modes of transport makes air travel highly inconvenient. Domestic market largely stays biased towards PIA through preferential route allocation, tax benefits and other protectionist policies, therefore making it difficult for new carriers to enter the aviation sector.⁹

d. Energy

Pakistan has been facing significant energy shortages since 2008-09. The main issue has however not been the capacity constraint but complicated market structure. Between 2003 and 2007, energy prices were not allowed to increase which led to increased dependence of private sector on government subsidies as a means to absorb fluctuations in their costs of production. Sharp increase in oil and gas prices throughout 2008 put enormous upward pressure on the cost structure in the power generation sector. While tariffs were not allowed to increase, subsequently much of this burden had to be borne by the government in the form of increased subsidy. But increased cost of war on terror and slow down in GDP growth led to government resources drying up and ultimately emergence of circular debt problem.

Table 4 Electricity Production (Mega Watt)

Years	Installed Capacity	Generation
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
<u>Jul-Mar</u>		
2008-09	19,575	6,940
2009-10 (e)	19,650	7,517

Source: Economic Survey 2009-10

⁹For discussion on how air transport infrastructure investment facilitates economic growth, see Hong et al. (2011) and Marazzo et al. (2010). For the case of Pakistan see Haque et al. (2011).

It can be observed from Table 4 that electricity generation started declining from 2006-07 onwards despite increase in overall installed capacity during the same period. However, data for last two years (shown only for period between July and March) shows a positive trend.

Despite frequent increases in electricity tariffs in last two years, a wide gap still exists between generation cost and recovery. Before the increases in tariffs, this gap was estimated to be around 30 percent. However, steps towards elimination of subsidy based tariff regime have helped reduce the circular debt to 120 billion rupees as of May 2010 compared to that of 216 billion rupees in June 2009.¹⁰

e. Water and Sanitation

Physical infrastructure continues to deplete in quality and its coverage is exceedingly inequitable; the poor stand deprived and disadvantaged – for water they pay exorbitantly to water vendors. The present level of coverage of water and sanitation in urban areas is stated to be 85 and 65 percent respectively but authenticity of these statistics is often questioned.

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

Local governments suffer technical, financial and administrative weaknesses in planning and in O&M related issues, especially related to energy requirements. These are also over-staffed agencies with an absence of adequately trained and professional manpower.

Moreover, underground sources of water supply are fast depleting due to heavy withdrawal and surface water is threatened with municipal discharges and pollution. Cities are increasingly faced with scarcity of water and poor quality of supplies. On the other hand 35 to 40 percent

¹⁰The 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), Hye and Riaz (2008).

water is wasted through leakages in the water distribution networks. Water treatment facilities are also limited.

Sewage is collected through open drains in most of the cities and discharge into rivers, streams, lakes and canals without treatment. These channels often become sources of urban water supply schemes. The collection through piped networks is limited to few large cities where too the coverage is selective and sewage treatment rare. Additionally in small towns incidence of open defecation is not uncommon.

Only 5 percent households have proper access to municipal garbage collection systems. Often there is no arrangement for its disposal at properly developed landfill sites. The uncollected garbage accumulates on streets, and open spaces between houses from where scavengers extract the useable material for recycling and leave the rest to rot.¹¹

f. Government Strategy towards Infrastructure

Given low levels of domestic resource mobilization and low expected tax revenues, public investment has been on a perpetual decline. Even in the existing structure of public sector development programme there is excessive share of civil work (almost 60 percent in 2011) leaving little space for social sectors such as education and health. Due to large sectoral and regional spread, public investment has been spread thin which does not allow for a focused strategy. The governance aspect of public investment needs immediate attention. Issues such as electricity and gas shortages are not capacity issues but management issues.

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 such as energy, water and transport that become inputs in the production process will require private participation and therefore rules for public private partnerships should be made as easy as possible. Finally projects for removing regional disparity should be initiated which can enable labour force particularly in war torn areas to become an active participant in the economic activity.

Due to fiscal crunch and lack of coordination between government departments the National Trade Corridor project was abandoned in 2011. The project was earlier envisaged to have an integrated focus on transport, logistics and economic growth. In Planning Commission (2011) it was realized that under the resource constraint new investment in infrastructure was hard to

¹¹The discussion on investment in water sector and its impact on economic growth may be seen in Barrios et al. (2010), Grey and Sadoff (2007). In case of Pakistan see World Bank (2008).

come by therefore government should focus more on improving management of existing infrastructure. This to some extent remains true as many public sector monopolies in the provision of infrastructure have underperformed due to structure inefficiencies. This document also talks about deregulating rail, road and aviation sectors for allowing private sector participation. Interest has already been expressed by China, India and other East Asian economies for direct investments in transport, logistics, oil and gas exploration.

It is pertinent to mention over here that autonomous or semi-government bodies such as WAPDA, OGDCL etc. chalk out their own investment plans in line with their own resource availability and projected cash flows. Besides some spending on infrastructure is directly made by provincial government – some of which have outlined their infrastructure priorities in the provincial economic reports.

4. Model, Data and Parameterization

Our modeling strategy tries to trace the overtime effects of public investment in infrastructure at the macro as well as micro (welfare effects) 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. Some heterogeneity is introduced at two levels i.e. households and firms which are both classified under constrained and non-constrained categories. The households or firms that are liquidity constrained and lack access to credit are termed constrained. For these households it is assumed that they save a constant positive fraction of disposable income. The households are owners of constrained firms and use their own savings as capital. Both households are assumed not to value leisure; therefore their labour supply is inelastic and is assumed which is 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 stock of public infrastructure is treated as input in the production function as a pure public good, and it has an impact on the productivity of the private inputs. However its productivity effects differ by industry. The use of the aggregate stock of capital used in this model is in contrast to Perrault et al. (2010) who try to disaggregate infrastructure into sub-sectors such as road, telecom, electricity and irrigation.

The firm sector combines factor inputs for producing a composite output marketed domestically and abroad (exports). Constant returns to scale are observed for public and private factors and all variables are expressed in terms of per efficiency unit of labour.

For each period all markets are assumed to clear. The labour market is adjusted through wages and goods market through prices of domestic good. For ensuring that savings equal investment, the constrained firms will only invest using savings of constrained households and dividends to non-constrained firms are net of investment. The total wealth of non-constrained households includes stock of foreign assets.

The dynamic CGE model is calibrated to the benchmark data given in social accounting matrix for Pakistan for the year 2007-08. We use the household budget survey for the same year for the microsimulation model. In the CGE model some external parameters are also used which amongst others include: substitution elasticity of CES households function (0.7%), substitution elasticity of first and second level CES production function (0.5 and 0.4% respectively), rate of depreciation (12%), output elasticity of public capital (0.3), share of public investment in total investment (28%), population growth rate (1.8%), world real interest rate (6%), 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 (for example Ahmed and O' Donoghue 2010). For details on comparable discussion on parameters please see UNIDO (2009).

Our microsimulation process consists of four different steps namely: estimation of being a constrained and non-constrained household, 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 by following the procedure proposed in Cockburn et al. (2011) for Benin.

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

The wage information is directly taken from micro level data and if wages are missing then predicted values are estimated by a standard Heckman selection model. Incomes from self-employment activities (retracing the economic sectors identified in the SAM) include observed or estimated revenues from production for market or for own-consumption. The changes in income from self-employment are taken from change in value of value added observed in CGE model. In order to estimate the value of value added we need to multiply the volumes by the prices and then get its change.

For calculating the per capita consumption, we associated every commodity (bought, own-consumed or received as gift) with 12 categories in macro and micro model. The consumption

values are converted to temporal basis in which the poverty line is expressed. These values were then summed up to derive the aggregate consumption variable in the base year and converted in per capita terms. In addition, a Cobb Douglas utility function was followed to estimate price deflators in order to take into account price differences across the simulation scenarios. The poverty and inequality estimation are based on consumption based measures.

Design of Simulations: The design of our simulation is such that we simulate a 4 percent increase in public infrastructure investment to GDP ratio. This increase takes the overall level of public infrastructure investment to GDP ratio back to levels observed in pre-food, fuel and financial crisis period. This simulation is in line with the intent documented in Planning Commission's *Framework for Economic Growth*. More specifically here we study the impact of a 4 percent increase in this ratio via financing means which include: a) international borrowing and b) taxation (production tax).¹² For each of the two policy experiments we look at the short, medium and long term impacts.¹³

5. Results

A tax financed increase in public infrastructure investment to GDP ratio by 4 percent leads to a strain on real GDP growth in the first period (declining by 0.06 percent). However growth recovers in the short run (within 5 years) and leads to a 1 percent gain over the longer run (Table 5). The total consumption follows a similar pattern where due to the increased tax burden total household consumption in the first period declines by 0.1 percent but gains 0.94 percent in the longer run. There is some redistribution taking place in the total household consumption levels as the increased taxes imply a greater gain for constrained households (1.2 percent) and a relatively lesser gain for non-constrained (0.2 percent) households (i.e. households having access to savings instruments). Primary this is happening due to increased incidence of tax on non-constrained households who own enterprises which face the distortionary production tax. The key enterprises which face this tax are those falling under the

¹² The reason for choosing production tax is that usually out of the wide range of indirect taxes, this is one of the easiest to implement in developing countries with lesser politically unfavorable implications (given that it is linked with growth in value addition). However this tax also has substantial intensity of distorting production and consumption patterns.

¹³ 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.

category of large scale manufacturing such as food processing, textile and construction related industry.

The main increase in overall investment comes from the public investment component which increases by over 5 percent in the longer run. However there are positive knock-on effects on private investment as well which increases by 2.3 percent (indicating some evidence of crowding-in phenomenon).¹⁴ Within the private sector investment the non-constrained firms gain by 2.7 percent over the long run. While constrained firms also gain in the short run and beyond however in the first period there is a decline of 0.27 percent in their investment levels. This can be attributed to the lag in transmission of increase in overall pool of savings to the constrained firms which are assumed in the model to be financed by own retained earnings.¹⁵

The price of capital and labour behave in opposite directions whereby the former increases in the short run but declines in the long run in turn resulting in greater capital formation.¹⁶ This may be attributed to the increased burden of taxes which takes away retained earnings in the short run, however public investment via increased taxation in the longer run leads to multiplier effect for both capital formation and ultimately economic growth. However the wage rate slumps in the first period by 0.32 percent and recovers in the short run and grows up to almost 2 percent in the longer run. The changing gains for the factors of production can also be attributed to the distortionary effect of the increased production tax.

On the side of external balance the foreign savings as a ratio of GDP are sustained in the vicinity of 3 percent. The key changes are seen in the trade account. Exports on account of early supply side losses (decline in output owing to increased burden of taxation) in first period decrease despite of a real exchange rate depreciation. After a decline of 0.2 percent, exports recover by 2 percent in the long run. There is some narrowing of trade deficit as imports grow at a lesser pace i.e. 1.6 percent in the long run.

Due to the overall increase that takes place in household and corporate incomes, private consumption, value added in manufacturing sector and imports – the government revenue increases by 1.2 percent in the first period and goes up to 2.3 percent in the long run. Income, consumption, value addition and imports are all taxed at various stages and therefore contribute to overall government revenues.

¹⁴ It is important to note that private investment has positively impacted despite of a production tax due to complementarities in public and private investment. However in the short term there is negative impact on private investment at disaggregated level and null effect on capital stock.

¹⁵ Public investment's positive externality in terms of expansion in private capital stock is around 1.7 percent in the long run.

¹⁶ The complementarity of private capital linked to the public capital increases and this produces an implicit surplus of private capital in the long run and hence pushing the price or returns to private capital downwards. In conjunction, labor become relatively rare and pushed the wages upwards.

It is important to look into sectoral impact of changes in GDP components (Table 6) as gross output in most sectors decreases in the first period but recovers in all sectors in the long run. An expansion in output also contributes towards decline in prices over long run. Most of this follows the underlying consumption pattern which decreased (due to increased burden of tax) except for manufacturing and construction. Total investment increased except for energy sector where it recovered in the short run.

The exports in the first period while increasing for most sectors declined for non-textile manufactured items, processed food and cotton. For non-textile manufactured items exports growth remained negative even in the short run and grew by 1.5 percent in the long run. The negative growth in export of public services can be explained in terms of fall in transport and logistics services provided by Pakistan to other countries seeking transit. This applies particularly to foreign governments trying to access Afghanistan through Pakistan.¹⁷

The domestic prices decline in most sectors except for cotton, non-textile manufacturing, and energy sectors (Table 7). Again there is some redistributive element as prices of agriculture and processed food items decline – a category more consumed (in budget share terms) by the poor segment of population. Subsequently the household consumption is to a little extent dictated by the underlying prices and the way they behave overtime.

We now look at the poverty impacts of tax financed public infrastructure. As this production tax is distortive therefore in the first period it adversely affects the poverty headcount through channels of reduced consumption and income. However overtime as greater infrastructure enables an expansion in supply side and reduction in prices, this restores growth of consumption and investment and thereby leads to improvement in poverty levels. Over the long run (20 year period in our microsimulations) we observe in Table 11 that poverty reduces by 0.3 percent. The variation in poverty is statistically significant at 95 percent confidence interval.¹⁸

We also see in Table 12 that increase in wages and proceeds from self employment are the main drivers of poverty reduction. The constrained households see a greater reduction in their poverty levels over the long run (Table 13). This is partially reflected by the relatively higher

¹⁷ There are other items under public sector services exports but the dominant share is that of transport and logistics services.

¹⁸ It is important to explain here methodologically as to how are factor endowments updated in the model. CGE results (regarding quantitative variables) are provided to the micro model in productive worker terms (it then takes into account change in population, labour and technology). This approach allowed us to leave the original micro-data unchanged. Then, changes in savings are introduced into the micro model. Also, the macro model did not distinguish workers by skills and sectors (full mobility across sectors), so the micro framework did not model education/skills evolution and labour mobility. Finally, we made the hypothesis that capital endowment is fixed.

increase in consumption levels of constrained households.¹⁹ Also one could argue that on the income side (at the macro level) the capital income of constrained households has increased relatively more than labour income. The capital income over the longer run has greater multiplier impact on economic growth and its components which in turn implies that households are able to increase their retained savings for future consumption (or investment).²⁰ A related point is that prices associated to the most important consumption categories decreased faster (or increased less) and that main sources of incomes increased faster (or decreased less) for constrained households compared with non-constrained households. In terms of provincial incidence of poverty (Table 14) we observe that Punjab has the largest gains in poverty reduction followed by Sindh. One way to explain this will be that Punjab hosts the largest number of constrained households which, as said above, are simulated to have larger increase in consumption. The inequality as measured by the Gini coefficient deteriorates in the first year on account of distortive taxation, however improves due to wage sector expansion in later periods (Table 15).

The second counterfactual that we study in this paper is the increase in public infrastructure investment to GDP ratio by 4 percent, financed by international borrowing. In this case (unlike the previous simulation) the real GDP growth turns positive starting from the first period, as borrowing represents foreign savings which in turn translates into investment gains. In the long run the overall impact of growth (1.3 percent) is greater than tax-financed increase in public infrastructure investment to GDP ratio. The total investment and household consumption both increase by 3.4 and 1.2 percent respectively in the long run (Table 8). As in the previous simulation infrastructure investment seems redistributive as constrained households gain more in consumption terms. Additionally under the present experiment constrained firms see an increase in investment levels starting from the first period (again pointing towards higher level of savings now available for investment purposes).

The wage rate continues to increase throughout the time horizon however the price of capital declines with time allowing capital stock to expand. The public and private capital stock sees an increase of 5 and 2 percent respectively over the longer run. The non-constrained firms due to their access to financial services manage a greater increase in capital stock.

On the trade side and due to increase of foreign exchange reserves the local currency becomes expensive relative to foreign currency. This in the first period implies exports becoming price

¹⁹ 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 having access to capital markets versus those not having such access. In the longer term access to financial services is expected to smooth consumption patterns. Given that one of the key aims of this paper is to see impact of infrastructure on household level welfare indicators – hence the reason for choosing this decomposition.

²⁰ However labor income has a greater share in the overall incomes of non-constrained households.

uncompetitive (indicative of Dutch disease kind of impact). As exports in the first period decline by 0.5 percent, imports see an increase of 0.84 percent. However both exports and imports see an increase in the long run as availability of more investment and better infrastructure improves the supply side. The additional international borrowing to GDP ratio continues to decline (0.09 percent over longer run) due to lesser borrowing requirements to fund incremental infrastructure. This is also attributable to rising government revenues in the long run. The overall increase in government revenue is higher than the previous simulation due to increased growth impact of foreign savings. Over the long run revenues increased by almost 3 percent. Here main drivers of revenue are direct taxes, consumption-based tax and imports.

The sector-wise results reveal that highest increase in gross output is in case of construction and non-textile manufactured items (which have employment prospects) followed by cotton and textile which are pro-export sectors (Table 9). In the longer run prices across the board decline (Table 10) and this partially explains the gains in household consumption.

Unlike the earlier simulation, under a policy experiment of infrastructure financing through international borrowing the gains towards poverty reduction can be observed from the first period. Throughout the time horizon these gains remain higher in comparison with tax financed infrastructure investment. The expansion in wages had the highest contribution towards poverty reduction followed by self employment gains.

While both household types see a reduction in poverty over the long run however constrained households see a relatively higher reduction in poverty headcount ratio. In terms of provincial incidence of poverty the results are similar to the earlier simulations where Punjab and Sindh province have a relatively greater reduction in poverty. There is an element of redistribution under international borrowing where inequality falls throughout the time horizon. We may conclude that infrastructure financing through international borrowing is less painful in the very short term – something which was not observed in the earlier simulation.

We should also at this point discuss the result as to why own-consumption did not lead to any reduction in poverty under both simulations. In quantitative terms this should be the case when own-consumption and/or the consumer price change are sufficiently negligible. In our case it seems to be a combination of both i.e. 3 out of 4 provinces have seen reduction in own-consumption stocks (explained below) and the low magnitude of price change.

The report by Sustainable Development Policy Institute titled *Food Insecurity in Pakistan 2009* highlights that the conditions of food security (including availability aspects) has deteriorated in 81 out of 131 districts of Pakistan.²¹ Around 49 percent of Pakistani population does not have access to sufficient food for an active living. There is evidence of inter and intra-provincial

²¹ In 2003 conditions of food security were found inadequate in 45 out of 120 districts.

disparities. For wheat production the report further explains that between 2003 and 2009 Pakistan experienced a 6 percent increase in surplus producing districts however the percentage of surplus food (wheat) available declined from 28.3 percent in 2003 to 17.5 percent in 2009 implying that majority of the provinces are now relying on external food sources. The above mentioned phenomenon is also supported by the observation that consumption of wheat has continued to decline due to lack of purchasing power (and rising global crop prices). Only in the year 2009 the decline in wheat consumption was 10 percent.

The above mentioned report goes on to discuss at least two important implications of the above mentioned with respect to the reduction in own-consumption. First due to the rising crop prices, 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 urban as well as in rural areas is to obtain caloric requirement from less preferred and less expensive food.

Finally it is important to mention that in a quantitative exercise such as this one more important than the magnitude is the direction of change in key macro and microeconomic variables. While both simulations point towards greater growth and poverty reduction prospects associated with increase in infrastructure investment, the choice between tax versus international financing (borrowing) will also entail political economy considerations.

6. Conclusion

In this paper we use a dynamic CGE model linked with a microsimulation model in order to estimate the macro-micro impact of public investment in infrastructure. 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 in the open economy process and have access to capital from inside and outside the country.

In our simulations we finance the public investment through two different methods. In the first case we raise the public investment for infrastructure through increase in production taxes and in the second case we finance through foreign borrowing. Our results reveal that the choice between tax versus international financing (borrowing) of public infrastructure investment quantitatively leads to results in similar directions in the longer run i.e. leading to macroeconomic gains and improvements in poverty level. However in the very short run (e.g. 1 year or first period) tax financing puts strain on the industrial sector's output (given that this

sector bears the largest burden of taxes particularly production tax) and thereby leads to a reduction in economic growth in the first period. However, financing from international borrowing has some Dutch disease kind of an impact in the first period indicated by a decline in exports. Most of our results particularly in case of real sector of the economy are in line with earlier work by Khan and Sasaki (2001).

The real GDP grew in the longer run by 1.01 and 1.29 percent under tax financed and financing through international borrowing respectively. For the same time period household consumption increased by 0.94 and 1.2 percent respectively. In case of tax financed increase the loss of consumption and investment in the first period is compensated via supply side expansion over the longer run. The poverty headcount ratio improved by 0.31 and 0.4 percent under tax financed and financing through international borrowing respectively. In both cases there is small improvement in inequality as well over the longer run.

Like with any other quantitative approach, our results should be interpreted in the light of model limitations. Furthermore impact of public investment depends not only on the size of investment but the efficiency with which this invested sum is utilized and absorbed. It also depends on the sectors in which the government intervenes. It is important not to compete with the private sector and instead only focus on areas that exhibit a market failure. In raising revenues through taxation, it will be important to see which sectors are taxed and in what manner. In order to allow direct taxes to increase, the government will have to take measures that remove market irritants and reduce barriers to entry and exit for the private sector.

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8. Tables

Table 5 Aggregate Results for Increasing Public Infrastructure Investment to GDP Ratio by 4% (Tax Financing)

Percentage change over base run

Variables	First Period	Short Run	Long Run ²²
Real GDP	-0.06	0.33	1.01
Wage rate	-0.32	0.51	1.86
Price of capital good	0.12	0.14	-0.02
Rental rate of capital of 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

²² In case of CGE results long run represents a 60 year period.

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 revenue	1.18	1.62	2.26
Increase in production tax rate (%)	3.43	3.03	1.73

Table 6 Sectoral Results for Increasing Public Infrastructure Investment to GDP Ratio by 4% (Tax Financing)

Percentage change over base run

	Food Crop s	Min or Crop s	Agri Processi ng	Cotto n	Livesto ck	Manufactur ing	Ener gy	Texti le	Constructi on	T&C	Privat e Servic es	Public Servic es
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	
Export												
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 Impact of Increasing Public Infrastructure Investment to GDP Ratio by 4% (Tax Financing)

Percentage change over base run

	Food Crops	Minor Crops	Agri Processing	Cotton	Livestock	Manufacturing	Energy	Textile	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	-0.20	-0.36	-0.05	0.20	-0.26	0.20	0.36	-0.15	0.23	-0.11	-0.10	0.31

run												
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 Aggregate Results for Increasing Public Infrastructure Investment to GDP Ratio by 4% (International Borrowing)

Percentage Change over Base Run

Variables	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 good	0.39	0.35	0.08
Rental rate of capital of 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 revenue	1.63	2.03	2.55
Additional foreign borrowings as % of GDP	0.21	0.17	0.09

Table 9 Sectoral Results for Increasing Public Infrastructure Investment to GDP Ratio by 4% (International Borrowing)

Percentage change over base run

	Food Crops	Minor Crops	Agri Processing	Cotton	Livestock	Manufacturing	Energy	Textile	Construction	T&C	Private Services	Public Services
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	
Export												
First period	-0.74	-0.43	-0.57	-0.38	-0.81	-0.42		-0.60		-0.39	-0.50	-0.57
Short	0.08	0.44	0.30	0.37	0.22	0.31		0.17		0.13	-0.34	-1.25

run												
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 Increasing Public Infrastructure Investment to GDP Ratio by 4% (International Borrowing)

Percentage change over base run

	Food Crops	Minor Crops	Agri Processing	Cotton	Livestock	Manufacturing	Energy	Textile	Construction	T&C	Private Services	Public Services
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 good												
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 good												
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 Increasing Public Infrastructure Investment to GDP Ratio by 4% on Poverty Headcount (% Change)

Simulations	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 How Household-specific Variables Impact Poverty Headcount in Long Run (% Change)

Variables	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 (% Change)

Variables	International Borrowing	Tax Financing
Constrained	-0.42	-0.34
Non-constrained	-0.38	-0.27

Table 14 Province-wise Poverty Reduction over Long Run (% Change)

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 Inequality (Gini Coefficient % Change)

Simulations	1 year	5 years	20 years
Tax Financing	0.0154	-0.0382	-0.1091
International Borrowing	-0.0315	-0.0651	-0.1206