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Quantifying the Impact of Development of the Transport Sector in Pakistan

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1. INTRODUCTION

An efficient transport system is not only a pre-requisite for economic development but is also important to achieve the objective of economic integration in the world economy. Insufficient transport infrastructure results in congestion, delay delivery time, fuel waste, pollution and accident[1] which built inefficiencies in the economy and costs the economy 4 to 6 percent of GDP each year [Shah (2006)and World Bank (2007)], which can be saved by investing in transport services.

Realising its importance, the government of Pakistan has initiated National Trade Corridor Improvement Programme (NTCIP) in 2005 to improve logistic and transport infrastructure so that it can fulfill the demand of economy more efficiently. This five years programme includes all sectors that improve performance of corridor-high way namely, road transport, railways, airports, and ships etc. The objective of the programme is to reduce the cost of doing business and improve quality of services. The study quantifies the efficiency of transport sector by evaluating the impact of public investment to improve transport services on the economy in general and on cost of land transportation in particular; i.e., cost of freight and passenger movement and cost of externalities such as congestion, air pollution and accident. The outcome of the study depends on how improved facility is achieved, i.e., who bears the cost and who benefits etc. This paper assumes tax financed public investment that not only change domestic price and demand, but also welfare and poverty. The issue is analysed in computable general equilibrium framework taking into account inter linkages of transport sector with rest of the economy. First, a social accounting matrix (SAM) is developed with a detailed transport module. Then, a dynamic CGE model is developed around this SAM and simulations are conducted for short run and long run analysis of public investment in trans port sector.

The Sections 2 and 3, respectively, presents review of the transport sector of Pakistan and review of literature. Section 4 describes the main characteristics of standard CGE model and modification made to it for the transport sector analysis. Section five

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[1]Accident problems cost about 2 percent of GDP [World Bank (2007)]. WHO points out that road safety is very important that can be reduced by investing in signs, training programme for drivers and improving the logistic. It smooth traffic flow, reduce frequency of accident, break down of vehicles and non-predictable situation.

explains the data base. Section six evaluates the simulation results. Final section concludes the paper with some policy implications.

2. TRANSPORT IN PAKISTAN

With 160 million of people, transport in Pakistan is one of the rapidly growing sectors. With all basic modes of transportation—road, railway, air, and water, it accounts for 12 percent of GDP higher than 6 percent in global economy. Road density is very low, 0.34 km/sq.km. In 2006, domestic transport[2] represents 1.29 percent of the final value of the commodities against a targeted value of 0.8 percent to be competitive at global level [Pakistan (2005)]. The detail of the transport sector and its facilitating components such as construction of roads, air ports and harbors and the stock of transport vehicles are briefly discussed in the subsequent paragraphs.

2.1. Road Network

Road transport is the most popular mode of transportation in Pakistan.

Table 1

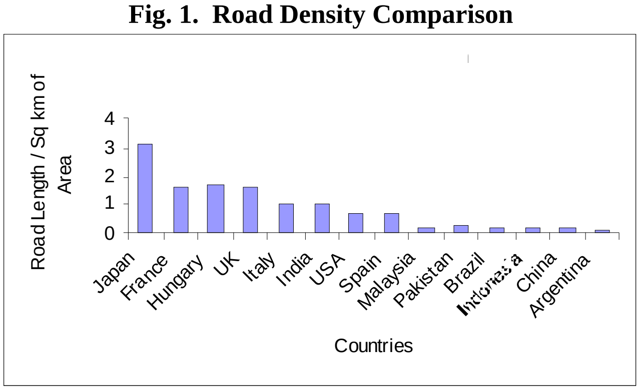
Land Transport in Pakistan

	Road			Railways					
	Road (1)	Vehicles (2)	Traffic Congestion= col 2/col 1	Route	Passen-gers	Freight Carried	Freight Tonne	Loco-motives	Freight Wagon in '000'nos
Year	000 km	No. in Mln		000 km	million	Million Tonne	Km Mln	Nos.	Nos.
1989-90	162.4	2	12	8.8	84.9	7.7	5.7	753	
1994-95	207.7	3	14	8.8	67.7	8.1	6.7	678	30.1
1999-00	248.3	4	16	7.8	68.0	4.8	3.6	597	23.9
2004-05	260.0	6	23	7.8	75.7	6.1	4.8	592	21.6
Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO2* Emission Metric Tons per Capita	0.69	0.75	0.73	0.74	0.75	0.76	0.78	0.75	

Source: Pakistan (Various Issues).

*World Development Indicators (2006).

Fig. 1. Road Density Comparison



[2]On average, it is composed of 18 products.

The government has initiated many projects to develop it. As a result, total length of roads has approached to 260 thousand km in 2004-5 with an increase of high type road by 88 percent since 1990 (Table 1). Currently, the country has 19 national high ways including motor ways of the length 9031 km under national high way authority (NHA). It accounts for 3.5 percent of Pakistan entire road network [Pakistan (2007)].

A cross country comparison shows that road density index can be used as a symbol of prosperity and development. Pakistan has very low road density, i.e., 0.3 compared 3.1 for Japan [Figure 1. *Source*: Pakistan (2006)]. Currently, Pakistan is endeavoring to gradually increase this density from 0.32km/sq.km to 0.64 km/sq.km. During 1990-2005, rail services have declined in terms of passengers and freight transport compared to road share due to priority changed by the government towards road transport (Table 1). However, in 2004-05, a positive trend in passenger traveling and freight traffic on rails have been recorded due to railway development projects implemented to improve in railway services.[3] In result, income of the Pakistan Railway has increased from 10.6 billion to 13.2 billion during 2003-04 to 2004-5 [Pakistan (2005)].

2.2. Air Travel Service

The Pakistan International Air (PIA) Line since it established in 1956 provides transport services on both domestic and international routes. The Civil Aviation Authority (CAA) manages and develops it. Various measures have been taken to develop a strong air transport infrastructure during the last fifteen years. (1) Installed a modern aircraft power system at Quaid-e-Azam International airport, (2) Renovation of existing terminal at Lahore, (3) Facilities at Nawabshah airport, (4) Construction of Sukkur terminal, (5) up gradation of Mohenjodaro Airport etc. Recently, an airport with joint private/public efforts has been completed at Sialkot. However, the revenue passenger kilometers (RPK) of PIA has not increased significantly despite increase in number of planes and available seats (Table 2). Table 2 shows that expenditure of PIA increase more than revenue over fifteen years.

Table 2

Pakistan International Airlines Corporation

Year	Revenue Km flown 000 (Mln)	Revenue Hours Flown 000	Revenue Passengers Carried 000 Mln	Available Seats Bln Km	Operating (in Million of Rs)		
					Revenue	Expenditure	No. of Planes
1989-90	62.6	120.9	5.1	14247.	16412	15728	43
1994-95	72.5	134.7	5.5	15848.	25417	24199	47
1999-00	75.9	134.6	5.1	18265.	36860	39214	46
2004-05	80.7	131.3	5.3	20348	61308	61175	42

Source: Pakistan (Various Issues).

[3]An amount of Rs 9.28 has been allocated for the railways during 2004-05 [Pakistan (2005)]. The development of railway includes manufacturing of 16 diesel electric engines, manufacturing of 66 coaches.

2.3. Ports and Shipping

Pakistan has three deep sea ports. Karachi port is a premier port of Pakistan and handles about 75 percent of the entire national trade. The total volume of cargo handled at Karachi natural port was 19 million tones including 15 million tones of imports and 4 million tones of exports in 1989-90. The cargo handling has doubled over the years (Table 3).

Table 3

Transportation of Goods and Services (Million of Tones)

Year	Cargo at Karachi Port			
	Total	Import	Export	No. of Shipping Vessels
1989-90	19.1	15.0	4.1	28
1994-95	23.1	17.5	5.6	15
1999-00	23.8	18.1	5.6	15
2004-05	28.6	22.1	6.5	14

Source: Pakistan (Various Issues).

Port Qasim is Pakistan's second deep sea port and meeting more than 40 percent of shipping requirements of the country becomes busiest port of the country. Currently a diverse range of commodities such as furnace oil, chemicals, edible oil, coal, wheat, fertilisers etc. are handled there. The cargo handling has significantly increased i.e., 43 percent during 2003-04 to 2004-05. Gwadar port is third deep sea port of Pakistan situated on the Balochistan port and is currently under construction.

Pakistan national Shipping Corporation is a group of companies operates fleet of 14 vessels with a total dead weight carrying capacity of 570466 tons (DWT). They are serving not only national trade but also participating in international trade.

Fig. 2. Private vs. Public Investment in Transport

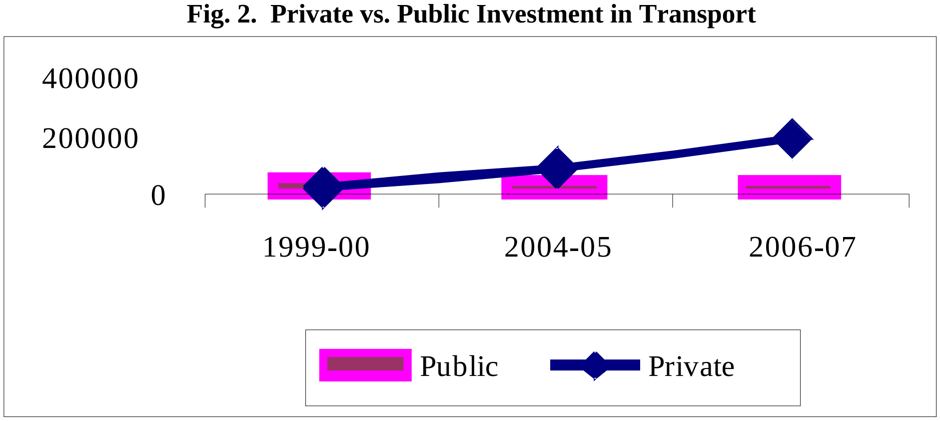
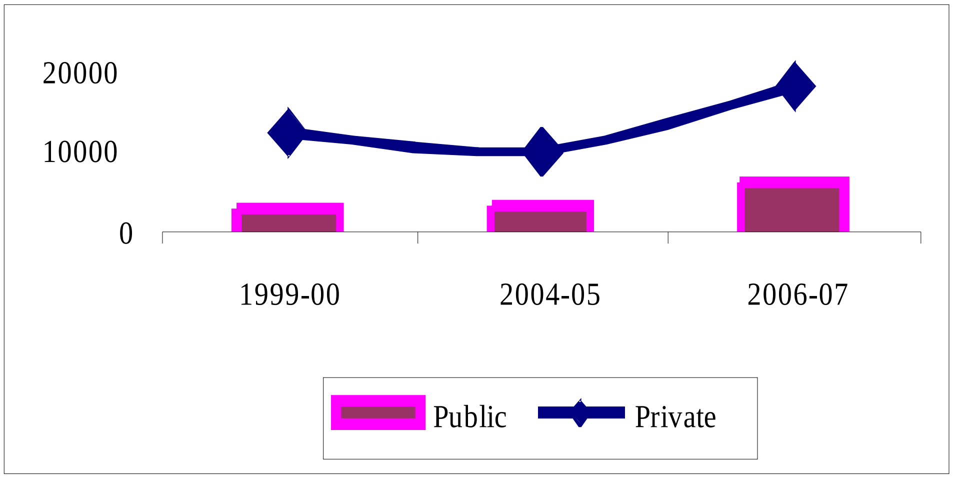


Fig. 3. Private vs. Public Investment in Construction



2.4. NTC—Programme of Pakistan [Pakistan (2007a)]

In the year 2005, Government of Pakistan has taken major initiatives around the National Trade Corridor (NTC) to bring the quality of transport services to international standards. The two objectives among others are: (1) reduced share of domestic transport and cost of non-factor services in the total value of commodities, (2) Improved safety and reliability of transport operations etc. The focus of the paper is on these two objectives of the NTC programme.

2.5. Investment in Transport Sector

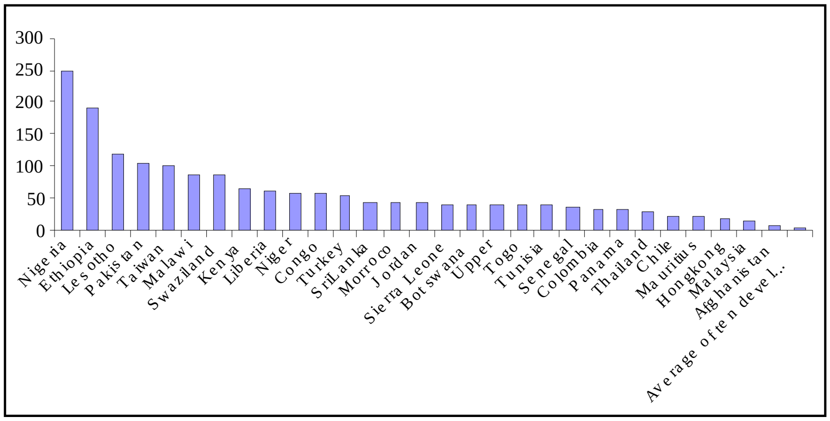
Construction as a whole contributes to growth process through higher multiplier effects with a number of backward and forward linkages.[4] The Figure 2 shows that private investment registered an increase, but public sector investment has declined in transport capital. Figure 6 shows that private and public investment in construction has increased, which includes transport-infrastructure also.

2.6. Externalities: Congestion, Pollution, and Accidents

Vehicles on the road have registered a sharp increase over the last fifteen years from 2 million to 6 million (Table 1), which has resulted in congestion i.e., vehicles per kilometer has increased from 12 vehicles/km to 23 vehicles/km. Air pollution is increasing function of transportation facilities. During 1995 to 2002, carbon dioxide emission has increased from 0.69 metric tons per capita to 0.75 metric tons per capita with an increase in traffic load on the road (Table 1). In the absence sufficient public transport infrastructure, tremendous increase in vehicles on the road has deteriorated air quality.

[4]The country has about 40 building material industries, which support investment and growth environment.

Fig. 4. Deaths per Thousand Vehicles



Road traffic accidents are also deteriorating for both human and physical loss. This is an important and preventable cause of death. Downing (1985) shows that Punjab (the largest province of Pakistan) has fatal accidents rate per million vehicles kilometers, 16 times higher than the rate for UK (0.49 compared to 0.03) (Figure 4). Razzak and Luby (1998) also shows that death rates for Karachi is much higher than cities in developed countries i.e., 11.3 people die per 10000 vehicles registered in Karachi, 1.4 die in Tokyo, and 2.8 die in UK (Manchester) for a similar number of vehicles. Fatality index is extremely higher for Pakistan i.e., 28 percent (4th highest of 29 countries).[5] The studies in other countries suggest that low cost engineering improvements have considerable potential for accident reduction.

3. LITERATURE REVIEW

A number of studies have evaluated transport sector development and the issues related to transport such as congestion, pollution, and accident using computable general equilibrium and partial equilibrium models. The CGE models have advantage over partial equilibrium models as they allow tracking of the changes in the economy not only in transport sector but can also be linked with other sectors and welfare and poverty. However, they do not allow for the same degree of modeling details of the transport sector as partial equilibrium models. The results of few studies are discussed below.

Conard and Heng (2006) develop a computable general equilibrium model incorporating congestion cost and determine optimal tax financed investment in road infrastructure. The results show that investment in infrastructure reduces congestion cost. However, the study ignores fundamental rule that a better infrastructure can generate additional traffic. Mayeres and Proost (2004) discuss various principles of transport pricing—average cost and marginal cost—with alternative ways to finance the deficit, marginal labour tax rate or transfers in general equilibrium frame work. The results show that welfare impact depends not only on presence of budget constraint but also on the flexibility with which that constraint is to be met, congestion and ratio of transport revenue to financial costing in the base year. The results recommend marginal cost pricing rule for welfare enhancing impact.

[5]The reason may be inadequacy of emergency health facilities.

Ellis and Hine (1995) analyse transport sectors using participatory mapping, historical time trend analysis, vehicle preference matrix, and semi-structured questionnaires. The study found substantial difference in transport tariff between Africa and Asia due to low vehicle diversity in African countries, which is result of low income level, insufficient support from the government, and poor back up services. To improve the supply or quality of rural transport services, and/or reducing the cost of their services should deregulate transport market. Government should promote alternative modes.

The study conducted by Bank's Independent Evaluation Group (IEG) [World Bank (2007)] consists of review of the Bank's assistance to the transport sector in developing countries over the last ten years. The review suggests that developing countries have made substantial improvement. They found that management is most important for improved out come. Increase private sector participation along with policies targeting to improved management especially in road transport have enormous impact on transport efficiency. IEG [World Bank (2007)] also pointed out that the cost of road accidents is a heavy burden on developing countries i.e., more than 3000 deaths result daily from road accidents. Low and middle-income countries account for 85 percent of such deaths and 90 percent of injuries (1 to 2 percent of GDP, more than the total development aid received by these countries.). WHO and World Bank suggest that such injuries are a growing public health issue, disproportionately affecting vulnerable groups of road users in developing countries. World Bank (1994) shows that infrastructure contribution to growth and poverty reduction could be significantly increased by strengthening incentives to transport suppliers in three ways: (1) more autonomous to management with accountability process. (2) Restructuring sectors and regulations to promote effective competition (3) giving users and the stakeholders more voice and responsibility in planning and regulatory arrangements. Downing (1995) using data from Pakistan indicate that low cost engineering improvement, particularly in black spot can reduce accident in the country if backed with improvement in training and enforcement. The study also shows that traffic police can be used for maximum benefits.

4. COMPUTABLE GENERAL EQUILIBRIUM MODEL

First, main characteristics of CGE model,[6] which is static and Walrasian in nature, are discussed. The model is extended with a detailed module of land transport.

4.1. The Characteristics of a Standard CGE

The model is built around social accounting matrix (SAM) for the year 2002 [Dorosh, *et al.* (2004)]. The SAM sectors, factors, and actors are aggregated from original SAM and some sectors (transport and other related sectors). The four types of economic agents are: two consumer groups, eighteen production sectors, the government and the foreign sector. Two primary factors are labour and capital. Two types of households are included in the model representing two regions of Pakistan—rural and urban. Consumers in different groups differ in their productivity and income they receive, transfers from government, firms, rest of the world and tastes. Households in the same groups are similar in all respects. It was assumed that markets are perfectly competitive and in the equilibrium all the factors and product markets are cleared.

[6]For detail see Siddiqui (2007a, 2007b), Siddiqui and Kemal (2006), Siddiqui, *et al.* (2006).

In the production process, price dependent input coefficients are used. Labour and capital together determines value added in each sector. CES technology is assumed between labour and capital. Producers maximise profits at the equilibrium—zero profit condition holds. The demands for factors of production, labour and capital are fulfilled with fixed supply quantities. In factor market, all factors can move freely and rental rates adjust to bring equilibrium in factor market.

The incomes from factors of production are distributed among institutions in fixed shares in the base year. Households receive all labour income, a part of capital income from production, transfer payments from the government, and dividends from firms. They also receive a certain amount of foreign exchange in terms of remittances that is used to finance the trade deficit. Household demand is specified by linear expenditure system (LES)-maximising Stone-Geary utility function subject to household's budget constraint. Their expenditure includes tax payments to government, which are specified as fixed shares of household income. Households' savings are specified as fixed share of their income. The government collects taxes from production and households and distribute (transfer payments) them among households (indexed to the domestic price level), to production sectors as subsidy payments and final consumption expenditure (of fixed commodity quantities). Government savings is defined as the difference between government revenues and expenditures. Enterprises income originates from capital and paid to households as dividends and rest is saved.

The Armington assumption is imposed—commodities produced locally are assumed to be imperfect substitute for the imported commodities and combined with CES technology. The economy is assumed to be a price-taker on the import side. The imports are subjected to an import tariff. In the market, the ratio between demands for products from these two sources depends on relative prices. The allocation of domestic outputs between domestic and foreign markets (Exports) is determined by the relative prices received in domestic and foreign markets. Constant elasticity of transformation is assumed between two types of goods. Export demand is a function of the ratio of world export price to domestic export price (fob) and base year export demand. The baseline equilibrium is characterised by a trade deficit, which is financed by foreign exchange to households (remittances).

Total supply in the domestic economy consists of domestic goods for local consumption and imports. Demand side consists of households' consumption, government consumption, intermediate input demands and investment demand. Consumer prices (composite) are determined by demand and supply equilibrium condition for each commodity. Total demand for investment and government consumption in real terms are determined by deflating with their respective price deflators.

The three blocks, savings-investment, government, and the rest of the world are associated with the macro constraints of the model. The total purchase of investment goods is financed by savings from the domestic institutions and the rest of the world. (ii) The fiscal balance—determined by the difference between government revenue and spending; and (iii) the external trade balance implicitly equates the supply and demand for foreign exchange. The difference between the two is current account balance (CAB).

4.2. Transport Externalities in CGE

This module is developed for in depth analysis of land transport system, which can be extended for other mode of transportation. The basic structure of the CGE model mentioned above is extended to incorporate congestion as in Conard and Heng (2006).[7] Congestion reduces the productivity of transport capital in the production sector and dependent on the stock of infrastructure associated with transport, roads, railways tracks, airports, and ports etc., which facilitates transportation of goods and passengers. Similarly, transport capitals (vehicles) such as cabs, buses, trucks, are included in the model explicitly, which are important to determine congestion, pollution and accidents. All these factors together determine the intermediate input of transport services in each sector. Air pollution and accidents do not affect consumer behaviour but indirectly affect domestic resources. The change in accidents leads to change the loss of GDP.

First we assume that transport services are proportional to the transport capital stock that can be improved by a better provision of transport infrastructure (KI)—construction of roads.

$$KT = KT^{o} EXP(-alpha\_tr / KI) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where *alpha_tr* >0 and as $KI \rightarrow \infty$ full utilisation of the stock of transport equipment KT^{o} is achieved. In other words, transport services depend on congestion *Z* (vehicales/kilometer) and elasticity ($\varepsilon_{KT,Z}$) of effective transport capital *wrt z* (congestion), which is less than zero. The equation is defined below

$$TR^{e}_{ser} = KT^{o} * Z^{\varepsilon_{KT,Z}} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad .. \quad (2)$$

The higher the *Z*, the less productive transport capital, which effect cost of production—transport services used to move goods and services from one place to other. Congestion index is defined below

$$Z = \frac{\prod_{i=1}^{N+2} (KT^{o})^{beta\_k}}{\prod_{i=1}^{N+2} (KT^{*}_{k})^{beta\_k}} \geq 1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Where *n*+2 is number of sectors and 2 households, KT^{o} is actual transport capital used in transport services and KT^{*} is optimal capital stock. An extended network of the roads and better connection between modes of transportation (increase stock of transportation) improves the efficiency of the stock of transport capital. Cost of transportation increases if Z>1. The stock of transport infrastructure (*KI*) in Equation 1 reflects the direct effect of *KI* on capacity utilisation which is defined below

$$CU(KI) = \exp(-\alpha / KI) < 1 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

Under optimal allocation Pc_cong (Price after including congestion cost) is defined below

[7]For a detailed discussion on this module, see Conard and Heng (2006).

$$PKT^s * KT^0 = PKT^1 * KT^0 + C_c^{cong} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

KT^0 is capital stock higher than the stock in the absence of congestion, which can be saved if more infra structure is provided. Congestion cost C_{cong} is defined as

$$C_{cong} = \beta_i [\sum \left| \varepsilon_{KT_j^{equip}} \right| * PKT * \hat{KT}^0] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

β_i is the size of externality (congestion) caused by industry *j*.

Taking the elasticity ($\varepsilon_{KT,Z}$) from Conard and Heng (2006), we calibrate cost of congestion in the absence of congestion data for Pakistan. To calculate congestion index Z we assume that actual stock of transport capital is 20 percent higher than required given the size of infra structure. If elasticity is high the congestion cost externality for the economy is high and stocks of KT should be reduced. In order to understand modeling of the direct and indirect effects of investment in transport infrastructure see Figure 1 in Appendix I.

The level of other two externalities, pollution and accidents,[8] are calculated with pre and post simulation data and do not affect consumer behaviour. The marginal external cost of accidents (net output losses in terms of transport capital goods, and medical costs) is calculated assuming that relationship between accident risks and traffic flow exists, which also depends on the investment in transport services [Downing (1980)]. The relationship between accidental fatality rate and per head transport capital is defined in Equation 7

$$\frac{ACC}{KT^e} = \alpha_{Tser}^{ac} [KT^e{}_{PC}]^{-\sigma_{TSER}^{ac}} \quad \ldots. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

Where *ACC* = Accidental cost, KT^e = total transport services using transport capital (vehicles) and KT^e_{pc} is transport services per capita. The value of σ (–0.44) is taken from Downing (1980) and alpha is calibrated using SAM values and population taken from [Pakistan (2005)].

The model evaluates the transport-fuel related emissions cost before and after simulations. Pollution creating input in transport in the model is petroleum. The change in provision of transport services lead to changes in demand for petroleum. As a result cost of emission changes. The change in transport services determine the intermediate input of petroleum which in turn determines the change in pollution cost associated with this input in transport. An equation [modified version of equation in Ryan, Miguel, and Miller (2002)] for emission associated with petroleum is introduced to calculate cost of emission as follows.

$$EN\_\cos t_{TR} = \sum_{i=TR} v_i^p * XS_i + \sum_{i=TR} \pi_i^p [\sum_{i=TR} ICJ_{TRj} + \sum_h C_{TRh} + \sum_{TR} OF] \quad \ldots \quad (8)$$

Where *XSi* is output of transport *vi* indicate share of emission of *co*2 from transport services production. *ICJ* is intermediate consumption of transport used by productive

[8]It is predicted that by 2020 road accidents will be the third largest contributor to the global burden of mortality and injury.

activities. Ctrh is households consumption of transport services, and *OF* is other foreign services. First environment cost associated with transport is calculated assuming same relationship exists between emission and transport services as total emission and output. Using emission data from World Development Indicators (2006) environmental cost of transport sector is calculated.

For the air and water transport, passenger and freight traffic are defined on the basis of input-output table. No other module for transport equipment or larger activities on airport and harbour has been included in the paper. For these two sectors, we discuss results with reference to change in transport services only.

4.3. Dynamic Features of the Model

For the long run analysis model is run for ten years. The capital stock is defined on the basis of an average capital output ratio (ACOR). One of the channels, suggested by new growth theory, by which trade enhances growth is that a country can obtain advanced technology from its trading partners through trade. The model incorporates it through change in factor productivity. Growth in labour force and total factor productivity (or technological progress) increases at an exogenous rate of two percent and one percent respectively. All other exogenous variables also increase with exogenous growth rate of two percent. The investment demand equation by target determines the pattern of reallocation of new investment among different sectors of the economy after the shock. The model is solved for each year.

The calibration of the model consists of the selection of parameters such that the behaviour of the economic agents around the bench mark equilibrium and their valuation of the transport externalities correspond with values given in the literature. Here, congestion is assumed to occur only on the road network.

5. CONSTRUCTION OF SOCIAL ACCOUNTING MATRIX

The starting point is SAM constructed by [Dorosh, *et al.* (2004)], which depict the situation in Pakistan in 2002 and represents the bench mark equilibrium. First, the production sectors are aggregated into 11 sectors from 34 sectors—agriculture, mining, manufacturing (food, textile, cement, wood, petroleum, and other manufacturing), construction, transport and other services. These sectors buy primary inputs from households and using them in the production process generates value added. In exchange of supplying factor services, households receive income as wages and returns to capital.

Table 4

Structure of SAM

Sectors in Original SAM	Disaggregation	Data Sources
1. Transport	1. 1. Land 2. Air, 3.Water, 4. Other	Supply and Use Table for 1990.
2. Petroleum	2. 5. Petroleum	SAM 1974-75 SAM 1984-85
3. Construction	3. 1. Land infrastructure [Road and Rail tracks], 2. Ports, 3. Air ports, 4. All other construction	National Account of Pakistan, Pakistan Integrated Household Survey(PIHS)
4. Other Manufacturing	6. Transport equipment, 7. Other manufacturing	

The main focus of the paper is to analyse the impact of development of transport infrastructure to improve transportation in the country. The SAM 2002 has four sectors which contain data to analyse the issue under focus—transport. 1. Construction, 2. Transport services. 3. Transport equipment (which includes transport vehicles). 4. Energy (Petroleum). Here, for the purpose of detailed analysis, construction and transport services are disaggregated by mode of transportation—land, air and water using information from various sources. Keeping all agriculture sectors together, industry and services sectors are disaggregated for the detailed analysis of transport services. Industrial sector includes transport related sectors; cement, wood (construction goods), transport goods (petroleum, transport equipment, and other manufacturing) and non transport sectors—food and textile. Construction and transport services have been disaggregated by mode of transportation; road, air, water. All other transportation activities are aggregated into one[9]. Rest of the services other than transport is aggregated into one.

Different types of construction activities are identified. The construction[10] activities differ in both nature of output and input structure, the output originating from construction sector flows to the ownership of dwellings and rest to investment. The construction sector covers all repairs, addition, alteration and demolishing activities carried out in the economy by households, private bodies, public institutions and the general government is considered as intermediate construction in each sector. The investment goods are determined by targeted sectors and disaggregated into private and public sector (Table 5). The table shows that transport services are energy (petroleum) intensive. Land, air and water transport use 57.5 percent, 45.1 percent and 46.6 percent of petroleum (Table 5).

The principal source of data on GFCF in building and infrastructure is from national accounts. The construction is associated with mode of transportation, the government is the principal agents. A distinction is made between passenger and freight transport services. Freight transport is considered as intermediate consumption, whereas final consumption expenditure of household on transport is considered as movement of passengers. The structure of cost of production is presented by mode of transportation in Table 6 shows that on average transport cost is 3.7 percent in production activity. It is relatively high for mining products and transport equipment, 10.1 percent and 8.2 percent respectively and very low in construction activities. The construction is activity which is produced at the place it is needed.

Land transport services are largely demanded by urban households (Table 7). Both urban and rural households with thirty and seventy percent of population uses 50 percent each of total land transport services. Air and Water transport are largely used by urban households in the domestic economy. Any improvement in this sector will benefit more to urban households. The unique feature is that the production of it is not storable and highly time and route specific.

[9]The storage include, oil and gas pipelines, transport handling, and services establishments and communication services rendered by Pakistan post office, Telecom, PTV, Radio etc.

[10]The construction sector covers all repairs, addition, alteration and demolishing activities carried out in the economy by households, private bodies, public institutions and the general government. New construction work and repair and maintenance of buildings and civil engineering work.

Table 5

The Cost Structure of Transport Services

Sectors	Land Transport (Road and Railway)	Air Transport	Water Transport	Other Transport
Agriculture	0.11	0.00	0.00	0.00
Mining	0.04	2.73	5.39	5.32
Food Manufactured	0.00	0.45	0.00	0.01
Text and Leather	0.14	0.27	0.16	0.33
Wood	1.86	0.23	0.04	0.01
Cement	0.01	0.01	0.02	0.06
Petroleum	57.54	45.11	46.56	1.52
Transport Equipment	6.29	0.09	2.22	7.96
Other Manufactured	16.24	37.57	0.53	57.26
Land-construction	2.19	0.00	0.00	0.00
Air-construction	0.00	0.83	0.00	0.00
Water-construction	0.00	0.00	1.48	0.00
Other-construction	0.00	0.00	0.00	6.94
Transport-Land	0.01	0.02	0.05	0.74
Transport-Air	0.02	3.36	0.15	0.52
Transport-Water	0.00	0.00	0.00	0.19
Transport-Other	0.06	1.29	0.91	1.04
Other Services	15.48	8.03	42.50	18.10
Total	100	100	100	100
Capital	39.2	58.4	82.0	30.2
Labour	60.8	41.6	18.0	69.8
Total	100	100	100	100

Table 6

Cost Structure of Production Activities

Sectors	Transport Services	Other Inputs	Value-added	Total
Agriculture	3.50	39.06	57.43	100
Mining	10.11	15.31	74.58	100
Food Manufactured	2.26	71.15	26.59	100
Text and Leather	3.82	74.78	21.40	100
Wood	4.25	59.46	36.29	100
Cement	3.25	41.78	54.96	100
Petroleum	3.02	77.62	19.36	100
Transport Equipment	8.24	37.51	54.25	100
Other Manufactured	4.69	59.62	35.69	100
Land-construction	2.77	59.97	37.26	100
Air-construction	0.00	61.68	38.32	100
Water-construction	0.00	61.72	38.28	100
Other-construction	0.02	46.86	53.13	100
Transport-Land	0.04	44.26	55.70	100
Transport-Air	4.26	86.87	8.88	100
Transport-Water	0.27	24.38	75.35	100
Transport-Other	0.46	18.17	81.37	100
Other Services	5.42	27.18	67.39	100
Total	3.74	46.55	49.70	100
Agriculture	3.74	46.55	49.70	100

Table 7

Demand for Transport Services (%)

	Rural Households	Urban Households	Rest of the World	Total
Transport-Land	50.26	49.74	0.00	100
Transport-Air	5.50	15.58	78.92	100
Transport-Water	4.59	4.80	90.61	100

6. SIMULATION EXPERIMENTS

The above model—with externalities—is subjected to assess the impacts of development of transport sector through tax financed public investment in transport infrastructure and transport services. These projects are costly and there is need to pay special attention to find financial resources. They can be financed through domestic resources or through multinational assistance. Domestic resources can be raised through increasing saving, cut in government expenditure, or raising government revenue through taxes, which can have different impact on macro aggregates and welfare and poverty. In this exercise we use tax financed investment. Following simulations are conducted for the short run and long run analysis. One year and ten years, respectively, are the time frame for short run and long run analysis.

- Business as usual (BaU) growth path.
- Tax-financed investment in transport sector.

The discussion of results focuses on the change in cost of production, demand for transport services and externalities. The performance of the transport is measured by change in transport cost, demand for transport capital, congestion, the emission and the accidents etc. The comparison of the results for short run and long run reveals how the conclusions change between the two periods.

The general equilibrium model presented in the earlier section treats, labour supply, government consumption in real term, CAB, exchange rate, public investment by target, remittance income, government transfers to households, transport capital, as exogenous variables. The model solves for local production, imports, exports, income levels, congestion, demand for transport capital, household income and expenditure, government revenue etc. All exogenous variables grow by 2 percent over the years.

In these experiments, public investment in transport infrastructure and transport services is increased by 20 percent. This type of government decisions require policy makers to have a good idea of the extra costs caused by the activity, Here, it is assumed that public investment is tax financed. The benefit/losses in the presence of market imperfections are measured by the variation in the cost of production which leads to change in prices not only of transport services but also in the prices of other goods and services produced in the economy and the change in returns to factors of production. The change in cost of production is the profit/loss of the producer. The users completely pay for resource cost. The change in this cost shows the benefit or loss to the users (consumers). Congestion is determined endogenously associated with demand for transport capital with given stock of infrastructure (transport capital/km). The cost associated with fuel emission and accidents are estimated before and after the policy shock exogenously based on values of transport services determined with in the model.

The development of transport infrastructure lowers the price of transport and the cost of production as well. On the other hand increase tax rate lead to increase in prices. The net change in prices determines the impact on macro aggregates. The exports of construction material (cement, wood, and other manufactured commodities) decline as domestic demand increases due to development of infrastructure, etc. The increase stock of infrastructure of road reduces congestion which lower demand for transport capital by firms and households. This lowers environmental cost also. Similarly improved transport services reduce accidental cost. For air and water transport the focus is on transportation cost only[11] not the pollution or any other externality. The changes in factor prices and government revenue determine equilibrium household income levels. The impacts on poverty depend on not only on income levels but also on price levels. The higher incomes and lower prices generate lower poverty incidences. Even with higher prices, poverty reduces if income increase is higher than price increase. The urban households are the main user of transport services so a reduction in transport prices would have positive impacts on urban households indicating that urban households get the advantage of lower prices due to investment in transport infrastructure than the rural households. However, they are also major contributor to domestic saving and if savings adjust to finance investment they bear larger negative effect in terms of consumption and welfare even in the presence of lower prices. Thus results are subject to the adjustment mechanism—closure. The following sections discuss the results of the simulations.

Simulation 1: BaU path

A dynamic CGE allows economy to grow in the absence of any policy change. First, a business as usual (BaU) path is depicted for one year and ten years which is used as a reference scenario for short run and long run analysis, respectively. This exercise takes into account efficiency effect as well as accumulation effects in the absence of any policy change. The results indicate growth path for 2003 to 20012 in the absence of any policy change. In this exercise output grows by 9.5 percent over ten years with value added growth 4 percent per annum on average. This shows decline in intermediate input mainly transport services. Exports expand by 9 percent over ten years. The results of simulations for short run and long run are compared to get an idea for future policy framework.

Simulation 2: Tax Financed Public Investment in Transport Infrastructure and Transport Services. (Short run vs. Long run Effects)

In this exercise public investment is used as instrument which entered the model as exogenous variables. Simultaneous increase in public investment in transport infrastructure and transport services by twenty percent for each of the three transport modes, land, air, water is fed into the model. Additional tax on consumption is imposed to raise resources to finance this investment. The results of this tax financed extension of transport infrastructure and transport services are presented in Tables 8 to 11.

[11]Majority of these services are used for export services, which need to be modeled in further detail.

Table 8

Macro Effects of Higher Public Investment in Transport (Variation Over BaU)

Variables	20 Percent Increase in Public Investment in Transport Infrastructure Financed by Consumption Taxes — Short Run	Long Run
Out Put	0.04	–0.04
Value Added	0.00	0.02
Consumer Price	0.00	–0.75
GDP Deflator	1.02	–8.46
Intermediate Demand	0.07	–0.10
Freight Transport Cost		
Transport-Land	0.24	–7.77
Transport-Air	–0.001	–3.24
Transport-Water	–0.16	0.29
Passenger Transport Cost		
Rural	0.05	–5.74
Transport-Land		
Transport-Air	0.11	–7.74
Transport-Water	–0.67	1.90
Urban	–0.18	–3.2
Transport-Land		
Transport-Air	–0.32	–4.93
Transport-Water	–1.07	4.55
Trade		
Export	0.11	0.06
Imports	0.02	0.00
Wage Rate	1.02	–8.4
Returns to Capital	0.00	–9.4

Table 9

Cost of Infrastructure Development—Variation over BaU Path

Variables	Demand for Construction Goods — Short-run	Long-run
Wood	0.10	2.74
Cement	0.20	11.36
Petroleum	–0.20	–1.74
Transport Equipment	0.24	9.17
Other Manufacturing	0.11	1.12
Transport Capital (Optimal)	1.7	–0.04

Table 10

Externalities

Externalities	Short Run	Long Run
Congestion Cost	0.10	–3.50
Pollution Cost	–0.12	–2.05
Accident Cost	–0.07	–1.15

Table 11

Households Income and Welfare Indicators

Short Run	Income	CPI	Poverty
Rural Households	1	0	Reduce
Urban Households	1	–1	Reduces
Long Run			
Rural Households	–8.2	–1.5	Increase
Urban Households	–7.9	–1.5	Increase

The first impact of increase in tax financed investment is that stock of transport infrastructure—road, ports and harbors—have increased. The price of land transport does not change in the short run but decline by (–3.1) percent in the long run. As a result, demand for land transport services (intermediate input) for freight movement rise by 0.24 percent in the short but decline significantly in the long run, by –7.8 percent. The households' demand for land transport (expenditure on travel) follows the same pattern in the rural area. But expenditure on land transport by urban households decline in the short run as well as in the long run, they are the major user of land transport. On the other hand, price of air transport and water transport rise in the short run by 0.9 and 1.03 percent, but significantly decline in the long run; –1.3 and –13.2 percent, respectively. This indicates public investment in the short run do not generate enough supply of infrastructure, which results in reduction in prices to compensate for the price hike due to tax raise. In the short run, demand for air transport and water transport decline by the producers for the freight movement and by households for passenger movement in the urban area. In the long urn air transport cost reduces in productive activities as well as expenditure by both types of households. The expenditure on water transport by all the three users increases with significant decline in prices. This proves the argument made by Down that better infrastructure provision generate additional demand [Conrad and Heng (2006)]. Though this statement is made for land transport, but this can be applied to other mode of transportations.

In the short run, taxes rise more than decline in prices. As a result price level in the country (GDP-deflator) rise by 1 percent. Though improved supply of infrastructure has negative effect on prices, but this effect is not enough to compensate for rise in taxes. The relative prices for all other commodities decline or remain unchanged leaving consumer price index unchanged in the short run. Wile in the long run consumer prices decline for majority of commodities due to significant decline in cost of transport services (freight cost and passenger cost). This indicates that development of transport services renders benefits in the long run. Consumer prices rise for transport equipment and petroleum (major input in transport services) by 1.4 and 2 percent, respectively (Appendix II, Table 1). The effect of rise in tax cancelled out by the decline in transportation cost of the users. As a result consumer price index (CPI) has declined by (–0.75 percent) in the long run over BaU value.

The effects on macro aggregates presented in Table 8 show that output has risen in the short run by (0.04) percent due to increase in cost of intermediate inputs which has risen by 0.07 percent. In the long run, value added increase over BaU value by 0.02 percent and output decline by 0.04 percent due to decline in cost of intermediate inputs by 0.1 percent. Intermediate cost associated with freight transport has declined in the long run significantly for land transport and air transport, whereas water transport rises which is mainly used for export purposes. However, this needs to be analysed further by extending the model.

Exports increase in the short run as well as in the long run by 0.11 and 0.06 percent over their respective BaU values. The demand for investment goods; cement, wood, and other manufacturing rises in the long run by (2.7, 11.4, and 1.1 percent) respectively (Table 9). Improved infrastructure provision reduces the demand for transport capital by (–0.04) percent over BaU value (Table 9). In result demand for petroleum fell by 1.7 percent.

The benefit of improved infrastructure provision includes the variation in prices of all goods and services, including land and labour. The change in other variables such as exports, imports, labour demand also reveals benefit or losses to the economy etc. Table 1 in Appendix II shows the impacts on volumes of goods produced, exported and imported in detail. A rise in export of all commodities can be observed except food and textile, which decline marginally.[12] Imports of mining commodities (a major input in petroleum sector) and petroleum (major input in transport services) increases significantly in the long run (Table 1 in Appendix II).

An increase/decline in labour demand can be observed in transport and other related sectors (Table 1 in Appendix II). An increase in production of construction and sectors related to transport and other sectors such as mining, cement, wood, other manufacturing have drawn resources from agriculture, food and textile. The changes in production activities, which ultimately have changed factor demand lead to significant decline in wage rate and capital rental rates by (–8.4 and –9.4) percent (Table 8), respectively, in the long run.

Congestion Cost

Congestion reduces transport services provided by transport capital in the presence of insufficient transport infrastructure.

The results show that tax financed development of transport infrastructure and services increase congestion cost marginally in the short run (0.10 percent) but significantly reduce congestion cost by (–3.5 percent) over BaU values in the long run. The results also show that increase stock of road reduces demand for transport capital by (–0.04) percent (Table 9). The reduction in congestion due to increase stock of transport infrastructure has led to firms lower transport capital (Table 9).

[12]The demand for these goods fell because of decline in households' consumption that indicates that welfare deteriorates. This can be explored further by changing the closure of the model.

Environmental Benefits/Loss. This is measured by the net difference in environmental costs between the BaU values and the simulated values. We assume that this difference does not influence the demand or the supply since these costs are not perceived by users or by producers and doest not feed back into the model. This effect is calculated exogenously in the model on the basis of change in transport services, which are endogenously determined in the model. The results show that reduction in demand for transport services and transport capital reduces air pollution by (–2.05) percent (Table 10), which would affect health status of the individuals positively. However, health indicators have not been included in the present model to measure change in health status.

Accident Cost

Accident cost is determined from the pre and post simulation values of land transport service using equation 7 given in the model. The results show that increase investment in transport sector[13] reduce accidental cost by 1.2 percent over the BaU value in the long run and by 1.08 percentage points over the short run impact (Table 10).

Households Income and Poverty Incidence

Table 11 shows the impacts on income and household's consumer price indices for the representative households. The income earned and CPI faced by each representative household reduces at different degrees depending on their base values of income and consumption.

The impacts on income poverty are positive in the short run as income of both households increase, whereas CPI for rural households remains constant but reduces for urban households. In the long run, the negative on poverty incidence can be deduced as income decline more than CPIs for both representative households (Table 10). But this will be thoroughly analysed at the later stage.

7. CONCLUSION

It has been widely recognised that economies with better road and communications network are more competitive and successful. A good transport system should be comprehensive and sustainable—economically, environmentally and socially. In view of this, government has started NTC improvement programme. The aim of the NTC program is to improve transport services, reduce costs of transportation which ultimately concerned with reduction in the costs of doing business. In this paper, the two objectives of the programs, have been focused; (1) Reduce share of domestic transport and cost of non-factor services in the total value of commodities. (2) Improve safety and reliability of transport operations etc.

These objectives largely depend on public investment. However, this type of government decisions requires policy makers to have a good idea of the extra costs caused by the activity and how it should be generated. This analysis include not only resource cost, but also the cost associated with externalities such as congestion cost,

[13]Traffic lights, yellow marks on the road etc.

accident cost,[14] and the environmental costs.[15] The transport users completely pay for resource cost. But fuel emission and accident cost is not perceived by the consumers and do not affect demand and supply of services. But it has detrimental affects on human life. These effects are estimated before and after the exogenous shock.

The results show that development of transport sector brings multi dimension benefits and help to achieve the two key objectives of NTC programme. Tax financed investment has reduced share of domestic transport and cost of non-factor services in the total value of commodities (first objective of NTC). It reduces transport cost associated with passenger movement too. It has improved safety and reliability of transport operations etc. by reducing environmental and accident cost (second objective). It has positive impact on growth and exports. The results show that tax financed public investment in transport and related sectors renders benefits in the long run, whereas in the short run it produces negative effect.

The reduction in cost associated with externalities shows that development of this sector bring about not only economic benefits but may also be helpful in reducing human poverty. However, this needs to be modeled explicitly. The main policies comes out of this study is that government should develop transport infrastructure for larger economic benefits in the long run. Taxes can be used to overcome the problem of resource constraint. The alternative way to finance the investment will be the focus of the future work to find optimal policy to generate financial resources. Government investment in transport services can help to avoid output losses.

In reality air pollution and accident risks also affect consumption choices. Such feed back effects—discussed in Mayeres and Regemorter (2003)—will increase the usefulness of the model. The air and water transport, are defined on the basis of input output table. No other module for these two modes is incorporated for detailed analysis. Other poverty targeted interventions such as schools, clinic nutrition programmes and even credit extension depend on transport in one way or the other. For instance, in developing countries, 40 to 60 percent of people live more than 8 miles away from health facilities. Development of transport infrastructure would also increase the benefit in terms of human capital development. Thus this sector has huge benefits. Further work is needed to unveil the total benefits of development of this sector.

[14]It is predicted that by 2020 road accidents will be the third largest contributor to the global burden of mortality and injury.

[15]Accident and the time cost have double dimension cost born by the users and the cost born by the other users on the road. At the time being it is not explicitly broken down into these components.

APPENDIX I

Fig. 1. The Impact of Congestion Z and Infrastructure K $^{\text{Infrastructure}}$ in a CGE Framework

	Input Structure by Industry	Final Demand
Petroleum Other Material	Intermediate Price Dependent Demand	Government Private Households
TR: $TR_{1(land)}$, $TR_{2(air)}$, $TR_{3(water)}$, $TR_{4(other\ transport)}$, $TR_{E(Transport\ equipment)}$ $=KT(KT^e, K^{infrastructure}).Z^{\varepsilon}$	Cost of Transportation as Input	KT_{+1}
Externalities* a. Congestion (associated with time input in transportation of goods and services from one place to other) b. Pollution c. Accidents d. Time	a. Congestion affects the cost of production and the level and structure of transportation input. Due to limited provision of infrastructure, congestion leads to firm’s higher stock of transportation capital. Investment in infrastructure lead to less transportation capital to distribute out put (but it reduces the life of capital goods). b. A large number of transport capital on the road lead to larger air pollution. This cost accrues largely because of low investment in signs and driving skills and this can only be reduced by improved management.	
Tax per KM	Payment to Government	
KT^0 K L	Capital used in transport Capital without transportation capital Labour	KT^e_{+1}
	Effective transportation capital services KT^e depending on Congestion Z by $KT^e = KT.Z^{\varepsilon_{KT}}{}^{ez}$ where ${}^{\varepsilon}{}_{KT}{}^{e}{}_{z} < 0$	

Source: Conrad and Heng (2006).

APPENDIX II

Table 1

Effects of Tax Financed Public Investment to Develop Transport Services

Variables	Consumer Prices		Exports of Goods and Services		Imports of Goods of Services		Value-added		Labour Demand	
	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Agriculture	0.00	–3.70	–0.23	3.60	0.42	–8.61	–1.3	0.01	0.0	–1.71
Mining	–0.88	1.89	–1.11	12.57	–1.56	8.45	15.7	–1.69	–1.7	15.35
Food Manufactured	–0.92	2.03	0.13	–0.91	–0.03	–3.94	–2.2	0.11	0.1	–2.59
Text and Leather	0.00	3.91	0.55	–2.17	–0.32	–1.58	–2.5	0.42	0.4	–2.86
Wood	0.00	0.75	0.00	3.58	0.21	–0.55	3.1	0.09	0.1	2.73
Cement	0.00	–3.57	–0.12	10.96	–0.28	–0.78	11.4	0.20	0.2	10.93
Petroleum	0.00	3.80	–0.14	9.24	0.36	6.95	–2.7	–0.07	0.0	–3.60
Transport Equipment	0.00	1.40	–0.01	2.11	0.14	0.46	12.5	0.06	0.1	12.19
Other Manufactured	0.00	1.97	0.00	0.00	0.00	0.00	2.1	0.05	0.1	1.72
Land-construction	–1.01	0.00	0.00	0.00	0.00	0.00	15.5	0.35	0.4	15.23
Air-construction	–1.01	–1.59	0.00	0.00	0.00	0.00	16.6	0.34	0.4	16.44
Water-construction	0.00	–1.59	0.00	0.00	0.00	0.00	16.3	0.20	0.2	16.14
Other-construction	0.00	–3.25	0.00	0.00	0.00	0.00	11.4	0.08	0.1	11.20
Transport-Land	0.00	–3.08	0.00	0.00	0.00	0.00	–3.0	–0.06	0.0	–3.42
Transport-Air	0.94	–1.26	–1.45	0.74	0.00	0.00	–0.6	–1.30	–1.3	–0.88
Transport-Water	1.03	–13.16	–0.74	15.00	0.00	0.00	14.1	–0.71	–0.7	13.91
Transport-Other	1.02	–5.30	–0.34	5.32	0.00	0.00	–1.2	–0.07	0.0	–1.75
Other Services	1.02	–3.94	0.00	0.00	0.56	–10.94	–0.6	–0.06	0.0	–0.92
Total	0.00	–0.75	0.11	0.06	0.02	0.00	0.0	0.00	0.0	0.00

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