AN APPLIED GENERAL EQUILIBRIUM ANALYSIS ON ECONOMIC IMPACTS OF ROAD TRANSPORT NETWORK IN PAKISTAN

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Abstract: Most of the developing countries face a lack of infrastructure facilities; where road transport network is one of them. In this paper, firstly for estimation of economic impacts of road transport network improvement in Pakistan, a multi-regional Computable General Equilibrium (CGE) model have been proposed. Secondly, it is explained how to estimate the inter-regional input-output table, which is needed for the calibration of this CGE model. Finally impacts of new road network connecting Karachi and Peshawar are analyzed by using the model. Through the analysis, it is showed that improvement of this road network will change the industrial structure in Punjab and North West Frontier Province (NWFP) regions of Pakistan, especially production of manufacture. Moreover, it is cleared that its benefit will be 16.0% of Pakistan 's GDP, and that most of it will be imputed in Punjab and NWFP region of this country.

Key Words: Computable General Equilibrium (CGE) Model, Benefits of Road Network Improvement, Pakistan

1. INTRODUCTION

1.1 Background of this Study

During last a few decades, many developing countries in Asia have experienced high rate of economic growth, and Pakistan is also one of them. Such trend is expected to continue next twenty years, but Pakistan will confront a lot of problems. Among them, road transport problem is crucial, that is how to improve the road transport network in accordance with the rapid economic growth. Road communication is playing a vital role in the transportation system of Pakistan. For past several years, the railway is unable to take its share of ever increasing transportation load. At present time the railways and road transport traffic load ratio is 12:88. It also indicates the need for massive investment in road infrastructure to take up this extra load.

The geographical location of major cities in Pakistan is shown in figure 1.1. Karachi, which locates in the south, is one of the major cities with population of 12.5 million (which comprises of approximately 10% of the Pakistan's population). And it has the only commercial seaport, handling all of the country's imports and exports. All other major cities are widely dispersed. Hence the establishment of a long distance road transport network system is quite important, especially to cities such as Lahore, Rawalpindi and Peshawar, which are located in Punjab and NWFP regions.

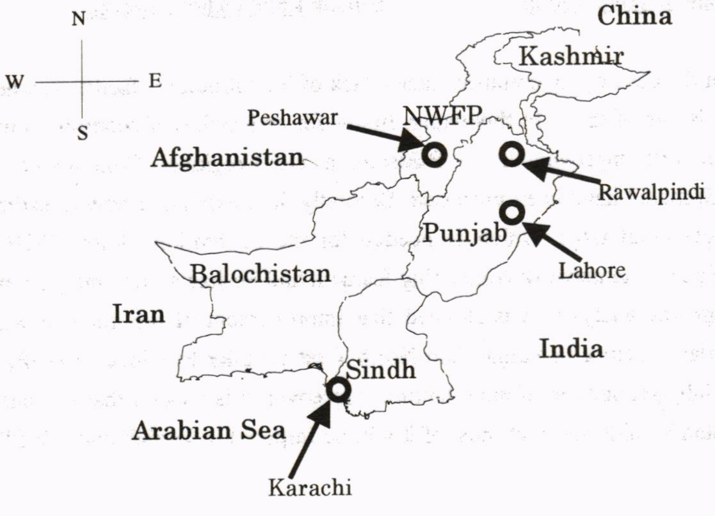


Figure 1.1 Regions / Provinces in Pakistan

1.2 Purpose of this Study

The purposes of this study are to know the regional economic impact of road transport network, interconnected with Karachi and other cities in northern part of Pakistan. In the next section, we explain a CGE model applicable to the developing countries in respect of economic activities and market structure. In section 3, it is shown how to estimate input-output (I-O) data, inter-regional input-output data and transport cost data. In section 4, we analyze economic impacts if the road network improvements would extend to Peshawar. In section 5, we mention about economic benefits measurement of the road network improvements.

2. A MODEL FOR ANALYSIS

2.1 Computable General Equilibrium (CGE) Model

Originally, a lot of CGE models have been used for forecasting economic growth of developing countries, where there are not sufficient data for development of econometric models. On the other hand, many CGE models have been developed for developed countries, and these have been used for impact analysis of tax reformation, changes of trade policy and so on. Moreover in some countries, regional CGE models have been developed for impact study of regional policies. In Japan, some multi-regional CGE models has been developed, which have been used for impact analysis of transport network improvements.

After road network improvements, firms and households will change their purchase pattern. Such changes in demand will cause other changes, for example, change of production pattern, and change of factor demand. In addition, price in each market will be changed to keep the balance between demand and supply. As a result of the price changes, industrial structure will be changed and regional structure will be reformed. So we should estimate such a structure change of regional economy after improvement of road network. Multi-regional CGE models specify price adjustment mechanism and by using them we can estimate change of interregional input-output table, which illustrate industrial and regional structure change after improvement of road network.

In this study, we propose a multi-regional CGE model for Pakistan, which has theoretical basis on a Japanese multi-regional CGE model (T. Okuda et. al. (1998)). And using this CGE model, we intend to analyze regional impacts of road network improvement for Pakistan.

2.2 The Economic Activities

An input-output (I-O) table used in this study is shown in table 2.1. The column of this table means economic activity and the row means market goods and factors. In this table, R denotes number of regions and S is assumed for number of industries in each region. As intermediate demand sectors, the following 3 types of producers are assumed; **(a)** industrial sectors (8 industries × 4 regions), **(b)** regional trade sectors (8 commodities × 4 regions) and **(c)** transport service sectors (8 commodities × 4 regions × 4 regions). As final demand sectors the following 4 types of consumers are assumed, **(d)** households (4 regions), **(e)** government (1 sector), **(f)** investors (4 sectors), and **(g)** export (1 sector).

The behavior of each sector is explained in the previous study (Okuda et. al. (1998)), in which CGE models are proposed for impact study of Japanese road network improvements. In this paper we explain only the behavior of regional trade sector as an example. We assume that regional trade sectors minimize their cost subject to the following production function.

$$y = f(A_1, \cdots, A_n, T_1, \cdots, T_n, M) \qquad (2.1)$$

Where y is output, A_i is input of domestic goods in region i, T_i is transport service needed to purchase domestic goods in region i, M is input of import goods. To specify this production function, we assume Constant Elasticity of Substitution (CES) functions, which are shown in Figure 2.1. This model uses a three-level nesting structure. The bottom level of this nesting structure means that producers must input transport service to purchase the commodities. The middle level means that they must purchase commodities produced in each region and that they are imperfectly substitutable. Therefore, if road network construction reduces the producer's input of transport service, they can change the pattern of inputs. Moreover the top level of nesting structure reveals the relationships between domestic goods and import goods, where domestic goods are composite goods of domestic goods produced in each region. In Japanese previous studies, it has been clear that this nested structure is statically significant.

Table 2.1 Economic Activities and Markets

		Industrial Sectors	Regional Trade Sectors	Transport Service Sectors	House-hold	Govern-ment	Invest-ment	Export
	Size	S×R	S×R	S×R×R	R	1	R	1
Industrial Sector	S×R							
Regional Trade Sectors	S×R							
Transport Service Sectors	S×R×R							
Import	S							
Labor	R							
Capital Stock	1							

S:Number of Industries (8)
R:Number of Regions (4)

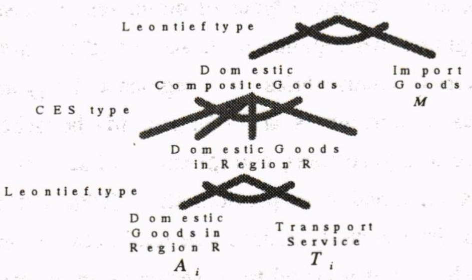


Figure 2.1 Structure of Production

2.3 Market Structure

Table 2.1 shows market structure in this study. The following 4 types of markets are assumed, **(a)** markets of domestic goods (8 sectors×4 region = 32 markets of goods), **(b)** transport service (4 region×4 region×8 sectors = 128 markets), **(c)** Imported goods (8 sectors), **(d)** factor market (one labor market in every region and one capital stock market in all Pakistan). And the equilibrium conditions satisfied that demand would be equal to supply in each market.

3. ESTIMATION OF DATA SET

3.1 Data Sources for the Estimation

Developed countries have enough data to constitute Input-Output (I-O) table, but developing countries do not have, especially about regional (provincial) level. So we should use some other database sources to estimate I-O table for Pakistan. The sources used are mentioned below:

(a) Global Trade Analysis Project (GTAP) is the source from which we can get I-O data of all over the world. But some countries' data are aggregated as arbitrary zones or regions. Unfortunately, Pakistan's data is not available directly in GTAP database. So we estimated I-O data of Pakistan approximately from the Rest of South Asia (includes Nepal, Bhutan, Maldives, Bangladesh only) in the GTAP data set.

(b) We also can get the different types of data from "Development Indicator Book"(World Bank). For example economic growth data, Gross Domestic Production (GDP) data, Population data and other statistics are useful for estimating I-O table of Pakistan from GTAP data set.

(c) We can get the sectoral shares in GDP of Pakistan and monthly household income in regional level from Federal Bureau of Statistics, Government of Pakistan. They are needed for the estimation of regional I-O table in Pakistan.

3.2 Estimation of Inter-regional Input-Output Table in Pakistan

We estimated I-O table of Pakistan for 1995 with data sets above-mentioned. Now we are ready to make inter-regional I-O table as shown in table 2.1. This table includes 4 regions and 8 industries, which are 1) Punjab, 2) Sindh, 3) NWFP, 4) Balochistan regions and 1) agriculture, 2) manufacturing, 3) mining, 4) construction, 5) electricity, 6) dwelling, 7) public and administration, 8) service industries.

At first Pakistan's I-O table was estimated from I-O table of Rest of South Asia in contents of

GTAP database. For this estimation, sectoral share of Pakistan in Rest of South Asia and I-O coefficient of Rest of South Asia are used. After that the I -O table was adjusted by RAS method. Secondly I-O tables of 4 regions in Pakistan were similarly estimated from the Pakistan's I-O table, by using sectoral share of each region in Pakistan. Thirdly, we estimated inter-regional I-O table in Pakistan from 4-region I-O tables. For this estimation, we needed inter-regional commodities flow data between 4 regions, which are estimated by using entropy maximization models under constrains (Wilson (1970)). As we don't have enough pages in this paper to explain more explicitly them, we intend to do in another paper.

3.3 Estimation of Transport Cost Table

We must estimate the transport cost table for making the table 2.1. In the I -O table mentioned above, transport cost is counted as inputs from the transport sector. However we must estimate the transport cost in each transaction. Generally speaking the frequency of transaction is counted by consumer's price (f.o.b price). When I-O tables are estimated by the producer's price, they are divided into transaction and transport cost, so that the transport cost is aggregated into inputs from transport sector. Therefore, for making a table as shown in table 2.1, it is necessary to divide the inputs from the transport sector. In this study, we modeled present road network of Pakistan, which includes 404 nodes and 415 links (shown in figure 4.1 and 4.2). Solving this network by Dijkstra method, minimum path of transport cost was calculated in every pair of regions. And then we divided inputs from transportation sector to each transaction by using the minimum transport cost.

4. ECONOMIC IMPACTS OF ROAD NETWORK IMPROVEMENTS.

In this chapter, we show the simulation results of improving new road network from Karachi to Lahore as case 1 and from Karachi to Peshawar as case 2.

4.1 Road Network from Karachi to Lahore (Case 1)

Karachi, a metropolitan area located in the Sindh region, is one of the major city having a population of 12.5 million (which comprises of approximately 10% of the Pakistan's population). Near Karachi, the second big city of Sindh region is Hyderabad with population of 3 million. Lahore, which is metropolitan area located in the Punjab region, is the second populated city of Pakistan 6.5 million. There are also a lot of populated cities near Lahore ex., involves Multan, Sahiwal, Jhelum. The road network plan of case 1 is shown in figure 4.1.

4.2 Road Network from Karachi to Peshawar (Case 2)

Peshawar, which is a metropolitan area located in the NWFP region, has a population of 2.5 million. There are also a lot of populated cities near Peshawar ex., Rawalpindi, Attock. The road network plan of case 2 is shown in figure 4.2.

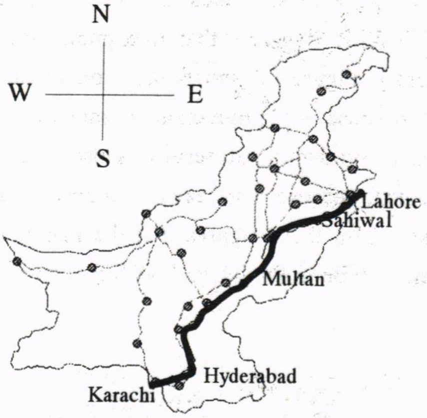


Figure 4.1 Road network Karachi to Lahore (Case 1)

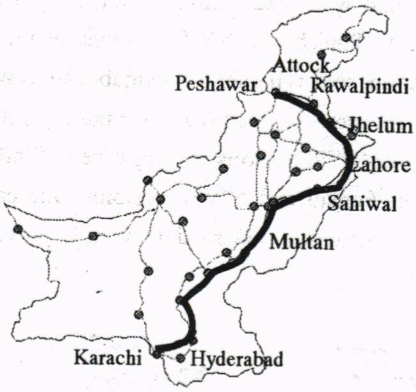


Figure 4.2 Road network Karachi to Peshawar (Case 2)

4.3 Impact on Transport Cost (T/C)

Figure 4.3 shows the economic impacts of road network on transport cost for two cases, where figure (a) and (b) describes the percentage of cost reduction accrued for case 1 and 2 respectively. In case 1 the maximum percentage of transport cost (T/C) decreased 38.5% Sindh to Punjab then 29.0% Sindh to Sindh, for case 2 transport cost decreased 41.4% also Sindh to Punjab then 29.2% Sindh to NWFP. These values show that projects have higher percentage of cost reduction in Punjab and NWFP regions of Pakistan. When transport cost decreased due to road network improvements project, the demand of goods on regional and international level will increase. It directly affect the production, which eventually affects rental price of land and labor cost, producers, and consumer's cost.

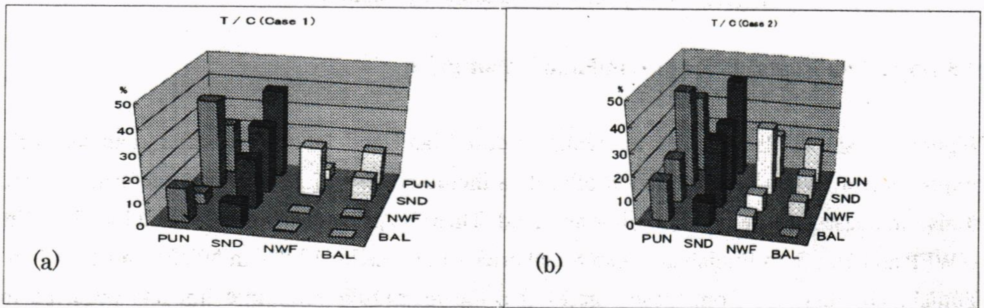
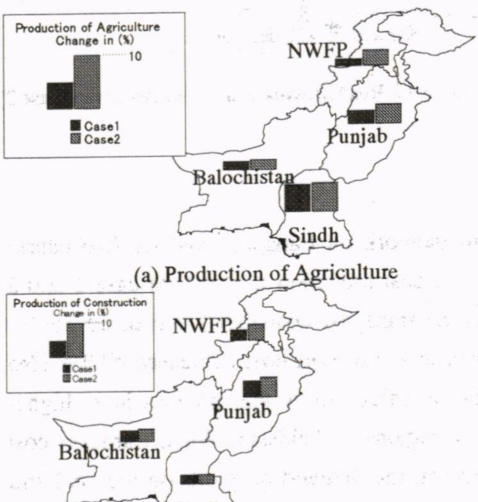


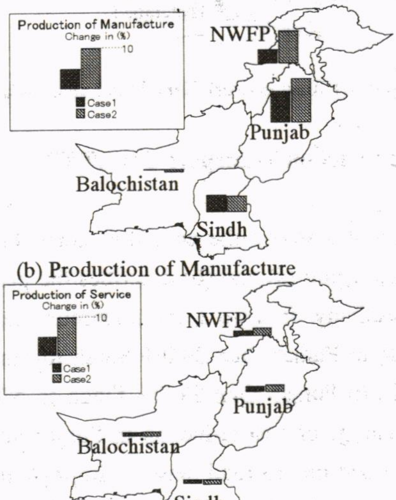
Figure 4.3 Impact on Transport Cost

4.4 Impact on Production of Sectors

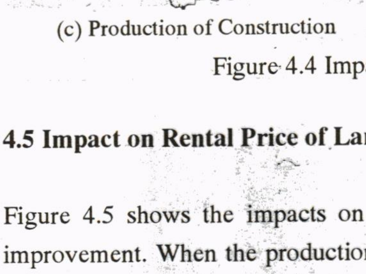
Figure 4.4 shows the impact on production after road network improvement. Figure (a) shows the production of agriculture sector increased in each region. On the other hand, Figure (b) shows the production of manufacturing sector for case 1, increase by 7.7% ($1,238 million) in Punjab and 4.3% ($655 million) in Sindh, and in case 2 these values are 10.7% ($1,351 million) and 8.1% ($23 million) for Punjab and NWFP. It shows that maximum impact occurred in Punjab and NWFP regions of the country. Figure (c) shows the production of construction sector higher in Punjab and NWFP, because the production of manufacture industry increases in these regions. Figure (d) shows the production of service is also much in Punjab and NWFP regions but negative in Sindh region, because more existing industries are located in Punjab and NWFP regions. One can see from these figures that the maximum economic impacts of new road network improvement will be in Punjab and NWFP regions of Pakistan.



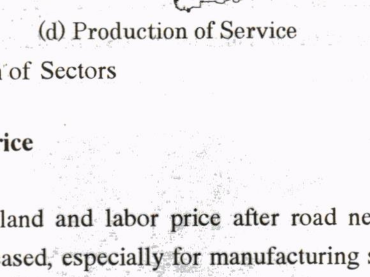
(a) Production of Agriculture



(b) Production of Manufacture



(c) Production of Construction

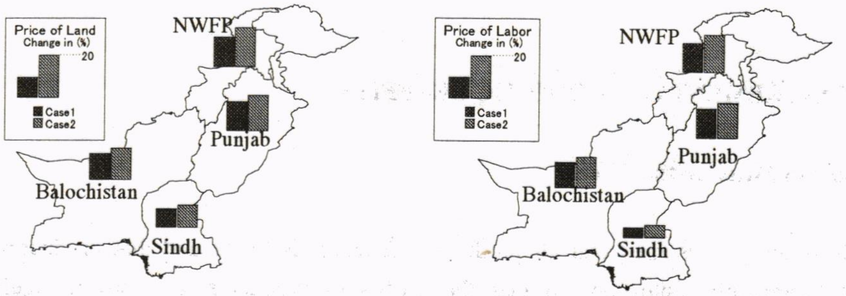


(d) Production of Service

Figure 4.4 Impact on Production of Sectors

4.5 Impact on Rental Price of Land and Labor price

Figure 4.5 shows the impacts on rental price of land and labor price after road network improvement. When the production of sectors increased, especially for manufacturing sector, it also increased the demand of labor and land. Then the price of labor increased by 17.9% in NWFP and 16.9% in Punjab and also rental price of land is by 18.8% in NWFP and 17.0% in Punjab. One can see from these figures that the maximum economic impacts occurred in Punjab and NWFP regions of Pakistan.



(a) Rental Price of Land (b) Price of Labor

Figure 4.5 Impact on Rental Price of Land and Labor Price

4.6 Impact on Producer's price

Figure 4.6 shows the impact on the producer's price (f.o.b price) of manufacturing sector after new road network improvements. When the production of manufacturing sector increased, the demand of labor and land will also increase. It also causes the cost of labor and land higher, which directly affects producer's price. In this figure one can see the producer's price of manufacturing sector increase by 5.4% in NWFP and 3.7% in Punjab for case 1, 4.8% in NWFP and 4.1% in Punjab for case 2.

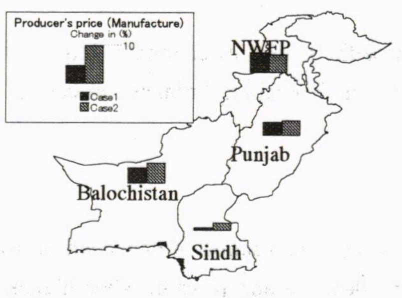


Figure 4.6 Impacts on Producer's Price

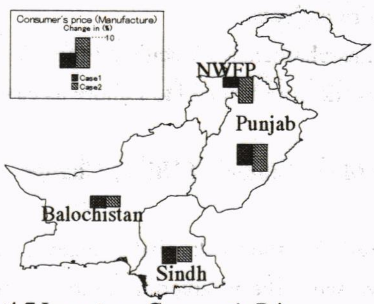


Figure 4.7 Impacts on Consumer's Price

4.7 Impact on Consumer's price

Figure 4.7 shows the impact on the consumer's price (c.i.f price) of manufacturing sector after new road network improvement. When the transport cost decreased by new road network, the consumer's price should be lower. Especially in Punjab 6.9% and 3.6% in NWFP for case 1, but in case 2 these values are 8.9% and 8.7% respectively. In this figure one can see the consumer's price of manufacturing sector decreases in Punjab and NWFP regions. It should be noted that connecting road network from Lahore to Peshawar is so meaningful for NWFP economy. In general speaking, consumer's price is equal to producer's price plus transportation cost.

5. MEASUREMENT OF ECONOMIC BENEFITS

5.1 How to Measure the Effects

In this study, we assumed that all production function is linear and that producers are in perfect competitive situation, so that the profits of producers are zero in equilibrium conditions. On the other hand, road network improvement makes changes in household utility. Therefore, we should evaluate economic benefits of network improvement by the utility change of households. It is known that there are some methods to measure the utility change, for example, Equivalent Variation (EV), Compensating Variation (CV) and so on. Using the CGE models, all indicators can be calculated, but in this paper EV are used as one of the indicators of utility change. EV can be calculated by the following equation;

$$EV = I_b \cdot \frac{U_a - U_b}{U_b} \tag{5.1}$$

Where U_b is utility before the projects, U_a is utility after the projects and I_b is income before projects.
In this chapter, we calculated the EV and show the results of economic impact of new road network from Karachi to Lahore as case 1, and from Karachi to Peshawar as case 2.

5.2 Measurement of Utility Change

Figure 5.1 shows the utility change per capita by construction of new road network. As we have seen, the production increase causes the demand and price of labor higher, so income level higher. Especially in Punjab 9.9% and 7.0% in NWFP for case 1, for case 2 Punjab 16.9% and 17.9%. It is also clear that the impact of connecting road between of Lahore and Peshawar is much prominent for NWFP economy.

5.3 Impacts on Equivalent Variation

Figure 5.2 shows the EV change by construction of new road network improvement, which means total benefits imputed in each regions. When production increase demand and rental price of labor increase, and also income level increase. In addition to that, there are a lot of people in Punjab. So there is high value of EV in Punjab for each case. For case 2, higher value is imputed is not only Punjab but also NWFP. From the figure one can see that, the maximum percentage of EV is obtained in Punjab and NWFP. The EV also shows the high economic impact of new road network improvement from Karachi to Peshawar, which is 16.0% GDP of Pakistan.

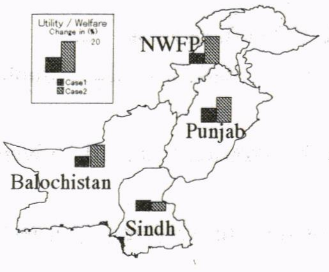


Figure 5.1 Impact on Utility change

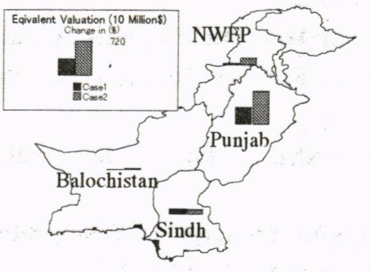


Figure 5.2 Impact on Equivalent Variation

6. CONCLUSION

In this paper, a multi-regional CGE model for Pakistan is developed. This CGE model includes transport cost data estimated from road network. In this model, improvement of road network decreased higher percentage of the transport cost in Punjab and NWFP regions of Pakistan. It seems to affect much industrial structure in Punjab and NWFP regions. More than that, the production increase of manufacture is striking, and also other industries, as construction sector. As we have seen, improvement of new road network decrease consumer's price of goods, so that the induced production also will increase the price of labor in Punjab 9.9%, 16.9% and also 7.0%, 17.9% in NWFP for case1 and case 2 respectively. The higher wage (income level) also increases utility level of household especially in Punjab and NWFP regions. Totally, the improvement of new road network increase 16.0% GDP of Pakistan, now it is clear that a new road network from Karachi to Peshawar is much important in economic viewpoint. In this study, by using this multi-regional CGE model, we analyzed economic impacts of new road network improvement connecting to other regions of Pakistan.

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APPENDIX A SYSTEM OF EQUATIONS

I Sectoral Input

(a) Production Sector

$$Z_A(i,j,s) = \frac{\bar{Z}_A(i,j,s)}{\bar{X}(j,s)} \cdot X(j,s) \tag{1}$$

$$F_A(j,s) = \frac{\bar{F}_A(j,s)}{\bar{X}(j,s)} \cdot X(j,s) \tag{2}$$

$$L_A(j,s) = \frac{\bar{L}_A(j,s)}{\bar{F}_A(j,s)} \cdot \left(\frac{PF_A(j,s)}{W(s)}\right)^{\sigma_F(j)} \cdot F_A(j,s) \tag{3}$$

$$K_A(j,s) = \frac{\bar{K}_A(j,s)}{\bar{F}_A(j,s)} \cdot \left(\frac{PF_A(j,s)}{R}\right)^{\sigma_F(j)} \cdot F_A(j,s) \tag{4}$$

(b) Regional Trade Sector

$$D_B(i,s) = \frac{\bar{D}_B(i,s)}{\bar{Z}(i,s)} \cdot \left(\frac{PZ(i,s)}{PD_B(i,s)}\right)^{\sigma_M(i)} \cdot Z(i,s) \tag{5}$$

$$M_B(i,s) = \frac{\bar{M}_B(i,s)}{\bar{Z}(i,s)} \cdot \left(\frac{PZ(i,s)}{PM(i)}\right)^{\sigma_M(i)} \cdot Z(i,s) \tag{6}$$

$$Q_B(i,r,s) = \frac{\overline{Q}_B(i,r,s)}{\overline{D}_B(i,s)} \cdot \left(\frac{PD_B(i,s)}{PQ_B(i,r,s)} \right)^{\sigma_D(i)} \cdot D_B(i,s) \tag{7}$$

$$X_B(i,r,s) = \frac{\overline{X}_B(i,r,s)}{\overline{Q}_B(i,r,s)} \cdot Q_B(i,r,s) \tag{8}$$

$$T_B(i,r,s) = \frac{\overline{T}_B(i,r,s)}{\overline{Q}_B(i,r,s)} \cdot Q_B(i,r,s) \tag{9}$$

(c) Transport Sector

$$Z_C(i,s) = \frac{\overline{Z}_C(i,s)}{\overline{T}} \cdot T \tag{10}$$

$$F_C(s) = \frac{\overline{F}_C(s)}{\overline{T}} \cdot T \tag{11}$$

$$L_C(s) = \frac{\overline{L}_C(s)}{\overline{F}_C(s)} \cdot \left(\frac{PF_C(s)}{W(s)} \right)^{\sigma_{FT}} \cdot F_C(s) \tag{12}$$

$$K_C(s) = \frac{\overline{K}_C(s)}{\overline{F}_C(s)} \cdot \left(\frac{PF_C(s)}{R} \right)^{\sigma_{FT}} \cdot F_C(s) \tag{13}$$

II Income and Expenditure

(a) Income Distribution

$$Y(s) = W(s) \cdot L(s) + R \cdot K(s) \tag{14}$$

$$Y_H(s) = (1 - \tau(s)) \cdot Y(s) \tag{15}$$

$$Y_G = \sum_s \tau(s) \cdot Y(s) \tag{16}$$

(b) Household Expenditure

$$C_H(s) = (1 - \mu_H(s)) \cdot Y_H(s) \tag{17}$$

$$Z_H(i,s) = \frac{\overline{Z}_H(i,s)}{\overline{C}_H(s)} \cdot \frac{C_H(s)}{PZ(i,s)} \tag{18}$$

$$U_H(s) = \prod_i Z_H(i,s)^{\frac{\overline{Z}_H(i,s)}{\overline{C}_H(s)}} \tag{19}$$

(c) Government Expenditure

$$C_G = (1 - \mu_G) \cdot Y_G \tag{20}$$

$$Z_G(i,s) = \frac{\overline{Z}_G(i,s)}{\overline{C}_G} \cdot \frac{C_G}{PZ(i,s)} \tag{21}$$

III Saving and Investment

$$I = \sum_s \mu_H(s) \cdot Y_H(s) + \mu_G \cdot Y_G \tag{22}$$

$$Z_I(i,s)=\frac{\bar{Z}_I(i,s)}{\bar{I}}\cdot\frac{I}{PZ(i,s)} \tag{23}$$

Ⅳ Export and Import

$$E=\sum_i\sum_s PM(i)\cdot M_B(i,s) \tag{24}$$

$$X_E(i,r)=\frac{\bar{X}_E(i,r)}{\bar{E}}\cdot\frac{E}{PX(i,r)} \tag{25}$$

Ⅴ Market Equilibrium Conditions

(a) Domestic Goods in Consumer 's Place

$$Z(i,s)=\sum_s Z_A(i,j,s)+Z_C(i,s)+Z_H(i,s)+Z_G(i,s)+Z_I(i,s) \tag{26}$$

(b) Domestic Goods in Producer 's Place

$$X(i,r)=\sum_s X_B(i,r,s)+X_E(i,r) \tag{27}$$

(c) Transport Service

$$T=\sum_i\sum_r\sum_s T_B(i,r,s) \tag{28}$$

(d) Labor

$$L(s)=\sum_j L_A(j,s)+L_C(s) \tag{29}$$

(e) Capital Service

$$\sum_s K(s)=\sum_j\sum_s K_A(j,s)+\sum_s K_C(s) \tag{30}$$

Ⅵ Price Balance

(a) Production Sector

$$PX(j,s)\cdot X(j,s)=\sum_i PZ(i,s)\cdot Z_A(i,j,s)+PF(j,s)\cdot F_A(j,s) \tag{31}$$

$$PF_A(j,s)\cdot F_A(j,s)=W(s)\cdot L_A(j,s)+R\cdot K_A(j,s) \tag{32}$$

(b) Regional Trade Sector

$$PZ(i,s)\cdot Z(i,s)=PD_B(i,s)\cdot D_B(i,s)+PM(i)\cdot M_B(i,s) \tag{33}$$

$$PD_B(i,s)\cdot D_B(i,s)=\sum_r PQ_B(i,r,s)\cdot Q_B(i,r,s) \tag{34}$$

$$PQ_B(i,r,s)\cdot Q_B(i,r,s)=PX(i,r)\cdot X_B(i,r,s)+PT\cdot T_B(i,r,s) \tag{35}$$

(c) Transport Sector

$$PT\cdot T=\sum_i\sum_s PZ(i,s)\cdot Z_C(i,s)+\sum_i PF_C(s)\cdot F_C(s) \tag{36}$$

$$PF_C(s)\cdot F_C(s) = W(s)\cdot L_C(s) + R\cdot K_C(s) \tag{37}$$

APPENDIX B LIST OF VARIABLES

I Suffix

i, j	Sector
r, s	Region

II Price Variables

(a) Production Sector

$PX(i,r)$	Price of goods in producer's place
$PF_A(j,s)$	Price of composite goods between labor and Capital Stock

(b) Regional Trade Sector

$PZ(i,s)$	Price of goods in consumer's place
$PD_B(i,s)$	Price of composite goods of domestic goods
$PM(i)$	Price of imported goods
$PQ_B(i,r,s)$	Price of composite goods between go ods and transport service
PT	Price of transport service
$PF_C(s)$	Price of composite goods between labor and Capital Stock

(c) Factor

$W(s)$	Price of labor
R	Price of capital stock

III Quantity Variables_

(a) Production Sector

$X(j,s)$	Output
$Z_A(i,j,s)$	Input of composite goods
$F_A(j,s)$	Input of primary goods,
$L_A(j,s)$	Input of labor
$K_A(j,s)$	Input of capital stock

(b) Regional Trade Sector

$Z(i,s)$	Output
$D_B(i,s)$	Input of domestic goods
$M_B(i,s)$	Input of imported goods
$Q_B(i,r,s)$	Input of composite goods between goods and t ransport service

$X_B(i,r,s)$	Input of goods in producer's place
$T_B(i,r,s)$	Input of transport service

(c) Transport Sector.

T	Output
$Z_C(i,s)$	Input of composite goods
$F_C(s)$	Input of primary goods
$L_C(s)$	Input of labor
$K_C(s)$	Input of capital stock

(d) Else

$Z_H(i,s)$	Household consumption demand
$Z_G(i,s)$	Government consumption demand
$Z_I(i,s)$	Input of capital formation
$X_E(i,r)$	Exported goods
$L(s)$	Labor supply
$K(s)$	Capital stock supply

Ⅳ Value Flows

$Y(s)$	Total income
$Y_H(s)$	Household income
Y_G	Government income
$C_H(s)$	Household expenditure
C_G	Government expenditure
I	Investment
E	Export

Ⅳ Parameters

$\tau(s)$	Rate of income tax
$\mu_H(s)$	Saving rate of household
μ_G	Saving rate of Government
$\sigma_D(i)$	Elasticity of substitution between domestic goods
$\sigma_M(i)$	Elasticity of substitution between domestic and imported goods
$\sigma_F(j,s)$	Elasticity of substitution between labor and capital stock input