An Impact Analysis of Transportation Network Development on the Regional Economy in Mongolia

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In developing countries, infrastructure development such as major transportation networks is essential for the development of the regional economy. On the other hand, many countries and regions have a history facing environmental problems and urban problems as a consequence of economic development and overcoming them. Therefore, it is necessary to learn from history and to formulate and implement regional development policies that are expected to have economic effects. In this research, with consideration to apply to local cities in Mongolia, we will develop an integrated evaluation model of environment, ecosystem and socio-economics in order to support decision making of local administration on regional development while considering sustainable development across the whole country. As the first step, an impact analysis of nationwide transportation network development on regional economy in Mongolia.

Key Words : *Mongolian transportation network, economic impact analysis, computable general equilibrium model*

1. INTRODUCTION

In developing countries, infrastructure development such as major transportation networks is essential for the development of the regional economy. On the other hand, many (developed) countries and regions have a history facing environmental problems and urban problems as a consequence of economic de-velopment and overcoming them. Therefore, it is necessary to learn from history and to formulate and implement regional development policies that are expected to have economic effects while minimizing negative impact on the environment. In this research, with consideration to apply to local cities in Mongolia, we will develop an integrated evaluation model of environment, ecosystem and so-cio-economics in order to support decision making of local administration on regional development while considering sustainable development across the whole country. As the first step, an impact analysis of nationwide transportation network development on the regional economy in Mongolia.

Fig.1 and Fig.2 show Mongolian major road and railway network, respectively.

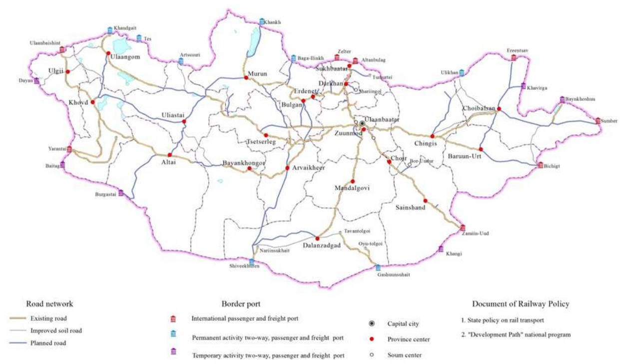

Fig.1 Road network map in mongolia

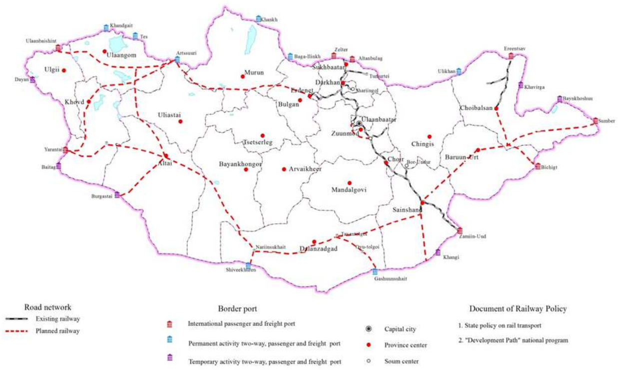

Fig.2 Railway network map in mongolia

2. THE MODEL

(1) Overview of the model

The SCGE model formulated in the following assumes that the whole nation is composed of N provinces. In each province, there are one representative household and M kinds of industries as economic agents. The model assumes that the i th industry in region k is represented by a firm ik, which produces one type of commodity i. Each firm maximizes its profit, and each household maximizes its utility. Each of markets is perfectly competitive and is in long-term equilibrium.

As to international trade, the consumer prices are expressed by adding cost of transport and tariff rate to the producer prices. The Armington assumption is introduced to describe specification of production districts. Transportation cost is expressed by iceberg model.

(2) Industrial sector

Firm i_k in region k uses the following inputs to produce commodity i: intermediate goods j transported from region l, labor and capital inputs provided by the household in region k, and utility inputs. It is also assumed that the production technology is characterized by constant returns to scale. in 10pt. bold face

Each firm maximizes its profit. This is equivalent to the following optimization problem.

1st tier

$$\pi_i^k = \max p_i^k Y_i^k - c_{Vi}^k V_i^k - \sum_j q_j^k X_{ji}^k \tag{1a}$$

$$s.t. \quad Y_i^k = \min\left\{\frac{V_i^k}{a_{Vi}^k}, \frac{X_{1i}^k}{a_{1i}^k}, \cdots, \frac{X_{Mi}^k}{a_{Mi}^k}\right\} \tag{1b}$$

2nd tier

$$c_{Vi}^k V_i^k = \min w^k L_i^k + rK_i^k \tag{1c}$$

$$s.t. \quad V_i^k = \left(L_i^k\right)^{\delta_{Li}^k}\left(K_i^k\right)^{\delta_{Ki}^k} \tag{1d}$$

where;

π_i^k : profit of firm i_k in region k (and so forth for k),

p_i^k : production price of commodity i ,

Y_i^k : output of firm i_k ,

V_i^k : the amount of composite factor of firm i_k , which forms value added,

c_{Vi}^k : the unit cost function for V_i^k ,

q_i^k : consumption price of commodity i ,

X_{ji}^k : the amount of intermediate input j for producing i ,

a_{ji}^k : input coefficient between the output of i_k and intermediate input j ,

a_{Vi}^k : production capacity rate of i_k ,

w^k , r : wage rate and interest rate,

L_i^k , K_i^k : labor and capital inputs for firm i_k ,

δ_{Li}^k, δ_{Ki}^k : share parameters between labor and capital of firm i_k ,

Solving (1a)–(1d), the following demand functions are obtained for firm i_k:

$$L_i^k = \left(\frac{r}{w^k}\frac{\delta_{Li}^k}{\delta_{Ki}^k}\right)^{1-\delta_{Li}^k} V_i^k \tag{2a}$$

$$K_i^k = \left(\frac{r}{w^k}\frac{\delta_{Li}^k}{\delta_{Ki}^k}\right)^{1-\delta_{Ki}^k} V_i^k \tag{2b}$$

$$X_{ji}^k = a_{ji}^k Y_i^k \tag{2c}$$

$$V_i^k = a_{Vi}^k Y_i^k \tag{2d}$$

(3) Household sector

The household earns income by supplying firms with labor and capital, and it consumes commodities or services to maximize its utility U^k. The utility maximization problem under a budget constraint can be described as follows;

$$U^k(\mathbf{d}^k) = \max_{d_i^k}\left\{\sum_{i=1}^M (\gamma_i^k)^{\frac{1}{\sigma}} (d_i^k)^{\frac{\sigma-1}{\sigma}}\right\}^{\frac{\sigma}{\sigma-1}} \tag{3a}$$

$$s.t. \quad \sum_i q_i^k d_i^k \le y^k = \sum_i \left(w^k L_i^k + rK_i^k\right) \tag{3b}$$

where y^k is the income of the household, which comprises labor income $\sum_i w^k L_i^k$ and rent of capital $\sum_i rK_i^k$, γ_i^k and σ are parameters, and d_i^k is the amount of consumption of commodity i.

Solving (3a) and (3b), the following demand function is obtained:

$$d_i^k(\mathbf{q}^k, y^k) = \frac{\gamma_i^k (q_i^k)^{1-\sigma}}{\sum_{i=1}^M \gamma_i^k (q_i^k)^{1-\sigma}} \frac{y^k}{q_i^k} \quad . \tag{4a}$$

Substituting (4a) into (3a), we obtain

$$U^k(\mathbf{q}^k, y^k) = \left\{\sum_{i=1}^M \gamma_i^k (q_i^k)^{1-\sigma}\right\}^{\frac{1}{\sigma-1}} y^k \,. \tag{4b}$$

(4) Formulation of Interregional Trade

The model consists of plural regions, and the interregional trade should be described. Our model assumes Armington assumption for dealing with goods of the same category but produced in different regions. Consequently, the goods are treated as a composite good in a consuming region.

Another assumption is the iceberg formulation of transportation costs (Samuelson, 1952). The transportation costs can be treated by evaporation of trading products themselves during transport, instead of configuring unique transport sectors.

The flow of goods –how much of goods does a region purchase from every region– can be described as a cost minimizing problem;

$$q_i^l X_i^l = \min \sum_k p_i^k (1+\phi_i^{kl}) x_i^{kl} \qquad (5a)$$

$$s.t. \quad X_i^l = \left\{ \sum_k \lambda_i^{kl} \left(x_i^{kl} \right)^{\frac{\nu_i - 1}{\nu_i}} \right\}^{\frac{\nu_i}{\nu_i - 1}} \qquad (5b)$$

where;

ϕ_i^{kl} : the markup on transportation of goods i,

λ_i^{kl} : share parameter,

ν_i : substitution parameter,

X_i^l : total regional demand of i in region l,

x_i^{kl} : the amount of goods i transported from k to l.

X_i^l , as the total regional demand is defined as the sum of the final demand on i and the intermediate input demand of firms.

The model assumes the iceberg formulation of transportation costs, and the markup related to transportation costs can be treated by evaporation of trading products themselves during transport, instead of configuring unique transport sectors.

The demand function of the unit composite good consumed in region l is found by solving (5a) and (5b).

$$\frac{x_i^{kl}}{X_i^l} = \left(\frac{\lambda_i^{kl}}{\tilde{p}_i^{kl}} \right)^{\nu_i} \left\{ \sum_k (\lambda_i^{kl})^{\nu_i} \left(\tilde{p}_i^{kl} \right)^{1-\nu_i} \right\}^{\frac{\nu_i}{1-\nu_i}} \qquad (6a)$$

where;

$$\tilde{p}_i^{kl} = p_i^k (1+\phi_i^{kl}) \ . \qquad (6b)$$

Consequently, the consumer price as composite goods is expressed by:

$$q_i^l = \left\{ \sum_k (\lambda_i^{kl})^{\nu_i} \left(\tilde{p}_i^{kl} \right)^{1-\nu_i} \right\}^{\frac{1}{1-\nu_i}} . \qquad (6c)$$

(5) Equilibrium condition

It is assumed that the commodity market achieves equilibrium between regions through spatial price equilibrium. Further, it is assumed that the labor market is closed in each region and the capital market is closed in the entire nation. The system's equilibrium is then achieved in these conditions. In this model, this is the condition that prevails before a disaster occurs. The balances in all the markets are described in the followings.

a) Labor and capital markets:

$$\sum_i L_i^k = L^k \qquad (7a)$$

$$\sum_k \sum_i K_i^k = K \qquad (7b)$$

L^k and K stand for the endowments.

b) Commodity market:

The balance equation is described as follows.

$$Y_i^k = \sum_l x_i^{kl} (1+\phi_i^{kl}) \qquad (7c)$$

The left-hand side of (7c) represents the commodity supply from region k, and the right-hand side denotes the summation of the share of region k in terms of commodity demand at region l. In other words, the right-hand side minus the left-hand side equals the excess demand of i in region k.

c) Spatial Price Equilibrium

The equilibrium prices of commodity are production and consumption prices in equilibrium state. Before a disaster, the production price is given from (1a) with zero profit condition:

$$p_i^k = c_{Vi}^k a_{Vi}^k + \sum_j q_j^k a_{ji}^k + q_u^k a_{ui}^k \ . \qquad (7d)$$

3. REGIONAL DATA

In order to achieve research purpose, province level input-output database is needed. We try decomposing national I-O data into province I-O by using some indicators.

The one indicator is "percentage share of GDP" in each province. It varies greatly from province to province, as shown in Table 1. Using this statistics, we first estimate sectoral output in each province. Next, assuming the input coefficient is common among provinces, intermediate input is calculated, and the horizontal adjustment of the table is made.

4. SCENARIO ANALYSIS

Details of the analysis will be given at the presentation.

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Table 1 Percentage share of GDP (%)

Province	Agriculture	Industry*	Services
Arkhangai	64	14	23
Bayanulgii	40	15	45
Bayankhongor	52	17	31
Bulgan	62	17	22
Gobi-Altai	50	17	32
Gobisumber	26	29	45
Darkhan-Uul	10	41	49
Dornogobi	34	18	48
Dornod	17	62	20
Dundgobi	63	10	28
Zavkhan	48	14	38
Orkhon	1	84	15
Uvurkhangai	52	16	32
Umnugobi	33	27	40
Sukhbaatar	43	38	19
Selenge	24	50	27
Tuv	59	19	23
Uvs	45	17	38
Khovd	46	16	38
Khuvsgul	46	22	32
Khentii	60	12	28