

## Modeling Road's Construction Effects on Attraction of Foreign Investment and its Regional Distribution in China

Yoshitsugu HAYASHI\*, Yang Zhong-zhen

### 1. Background

From 1980 to 1993, China invested large amount in its roads' construction, especially in its expressway's construction. Simultaneously, with its "reform and open" policy, China has introduced lot of foreign investment. In order to optimize road's investment and make fair payment against development gains, it is necessary to analyze roads' construction effects. Now in China this analysis is limited to the direct effects but neglects the indirect effects such as roads' impact on land-use, production and employment.

As all know, in China the roads construction is one of the most important factors for prompting regional economy and foreign investment. Compared with direct impact, the indirect one is also very important. The aim of this study is to develop a model which can estimate the expressway's effects on the amount of foreign investment and its regional distribution in China.

### 2. Introduction of Analyzing Method

We can analyze transport infrastructure's effects from both micro and macro level. At the micro level we deal with individual observations on actors who are expose to and hence affected by transport infrastructure. Micro study are normally related to survey methods( e.g. questionnaires, interviews, self-administration). It should be noted however, that acquiring this kind of information is costly and time consuming.

A central question in micro studies that aims to analyze the importance of infrastructure for economic development is the extent to which the quality and quantity of infrastructure is an important location factor for a company. Besides, it is hardly possible for us to give an impression of possible effects in case of "infrastructure off situation". Furthermore generation and distribution impacts are generally not distinguished<sup>(1)</sup>.

The class of macro approaches is not entirely separated from micro analysis, as macro studies are often based on aggregated results of micro-based survey held by bureau of statistics but they sometimes less costly and time consuming than micro approaches. In this study we will use macro approaches because of this advantage.

In macro approaches, there are two kinds of

models: multiple-equation models and single-equation models. Multiple-equation models can be subdivided into Input-Output models and General Simultaneous models.

These kinds of models make it possible to consider the various impacts of transport infrastructure on various regional profile elements. They are also able to catch the causal relations between infrastructure and regional development. But they also need large amount of data. For example when analyze effects with input-output method, regional input-output table must be needed.

Models based on single-equation approach have various advantages. Firstly, these kinds of models are very easy to use. Secondly, the amount of data required is relatively limited. Single-equation models used for infrastructure effects analysis can be based on different approaches viz., the Production Function approach and Location Factor approach. In Production Function approach, make infrastructure's investment as a production factor to estimate the impact of transport infrastructure on regional production. In location approach, infrastructure plays a roles - besides other factors - as strategic location factor.

In China because the reform from planned economy to market economy is just implemented a few years, there is not plentiful data for us to use. Subject to this data limitation, in this study based on single-equation approaches we develop a model which can analyze the generation and distribution effects of road infrastructure on foreign investments in China just with the data from Statistic Bureau. The case study region-Liaoning Province is an "open region" in Chinese Eastern-Coastal area.

### 3. Relation between Road's Construction and Foreign Investment in China

#### 3.1 Economy Growth and Transportation

China's GDP grew at 12% each years during the period from 1980 to 1993. Because this fast economy growth the transportation volume also increased quickly.

From Figure-1 we can see that roads' transportation increased with the same trend of GDP and faster than railway's. The reasons of this situation are (1) the burden of railway is too heavy for it to enlarge its operating volume, (2)the government encourages short-distance transportation to use road instead of railway, (3) the railway is dominated by government, it is difficult for customers to use it, but the roads are so flexible that user can use it at any time easily. The users

Keyword: Construction Effect Assessment Method

\* Member of JSCE, Professor, Geotechnical & Environmental Eng., Nagoya University, Chikusa-ku, Nagoya 464-01 Japan

\*\* Student member of JSCE, Graduate student, Geotechnical & Environmental Eng., Nagoya University.

especially the no-state owned enterprises such as foreign or farmer's enterprises would rather like to use roads because of its convenience and in time.

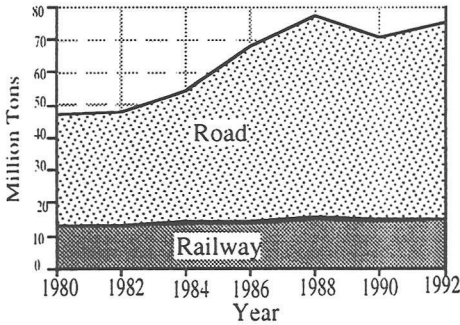


Figure-1 Freight Traffic by Model In Liaoning

### 3.2. Expressway's Construction

The roads construction in China now is in its boom. In this boom the expressway with its high speed and great capacity attracts attention. From 1988 the length of expressway in China increased quickly. As shown in Figure-2 in order to supply good conditions for foreign investment as well as prompt economy, the constructed expressways are mainly located in the Coastal Areas, furthermore almost all of their beginning points are harbor cities.

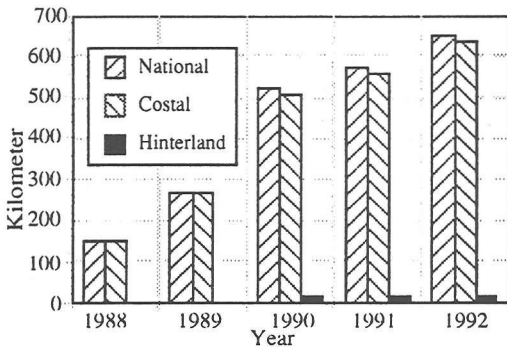


Figure-2 Distribution of Chinese Expressway

### 3.3 The Characteristics of Foreign Investment in China during 1980-1993

From 1980, because of the "reform and open" policy, foreign investment began to enter China. The investment situation in Liaoning Province is shown in Figure-3

The reasons why foreign companies invest in China are manifold. We list the main reasons as follows.

(1) The developed countries are in the process of restructuring their economy. They want to transfer some industries outside. There are also a lot of surplus capital around the industrial countries.

(2) The developed countries want to make use of the cheap labors and some other production

factors to make their products much more competitive in international market.

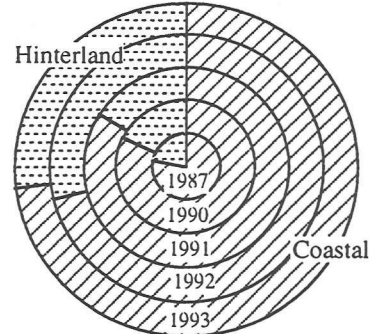


Figure-3 Foreign Investment in Liaoning (Expressway which connects harbor with hinterland cities was Finished in Dec. 1990)

(3) The 1.2 billion population means there are big markets in China. Whoever wants to exploit this large potential market, they must establish their companies or factories in China.

Considering (1) and (2), accessibility from the investing sites to harbors is so important that at the beginning investments mainly concentrated in the coastal cities. As the increment of foreign investment in coastal cities, the production cost such as salary, land and service became expensive. So afterward considering cost factors and (3), foreign investment began to scatter into hinterland cities which have a good transportation condition rather than just concentrating in coastal cities. In this process the accessibility among the cities in a region becomes very important for foreign investment.

From Figure-4, we can know that foreign investment mainly concentrated in manufacturing industries rather than other fields. This is also a reason why road transportation is very important for foreign investment.

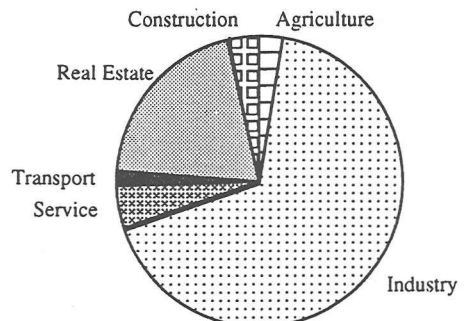


Figure-4 Shares of Foreign Investment in Each Field in Liaoning(1980-1993)

### 3.4 Effects of Expressway's Construction on Foreign Investment

Expressway's construction can shorten the transport time from city to city. Especially for foreign enterprises which are import-export oriented, it can shorten the transport time and cost from other cities to coastal cities. As a result both the accessibility among cities in this region and the accessibility of this region to the outside increased. These Accessibility have two effects on foreign investment.

1 **Generation Function**: Because of the accessibility's rise, the attractiveness for investments will increase. More investment will be generated into this improved region.

2. **Distribution Function**: Because not only the first kind of accessibility but also the second one rise, the generated foreign investment will scatter into every city according to Random Utility Theory rather than concentrated one or two sites.

We explain expressway's effects on Foreign investment in Figure-5

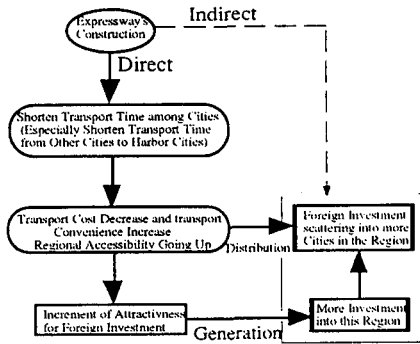


Figure-5 Effect of Expressway On Foreign Investment

#### 4. Modeling Expressway's Effects on Foreign Investment

##### 4.1. Measuring the Generation Effect

As above analyzed, besides the economic and political reasons, the accessibility of a region is essential for foreign investment. Hereafter suppose the attractiveness of a region for foreign investment is represented by the accessibility of this area. Furthermore the accessibility can be divided into two kinds: accessibility to the outside and accessibility between cities in the region. According to this assumption we model the attractiveness as follows.

**Suppose**: In region there are  $N$  cities and among them  $N_1$  cities are coastal cities.

##### (1) Accessibility to the Outside

Because foreign enterprises export 80% of its output, so  $P_j$  can represent their transport volume from production-sites to harbors.

$$Acc = \sum_{j=1}^N \sum_{i=1}^N P_j FT_i f(c_{ij})$$

$Acc$ : Accessibility to the Outside;

$P_j$ : Foreign enterprise production value in city  $j$ ;

$f(c_{ij}) = \frac{1}{c_{ij}^\gamma}$ : Transportation resistance ;

$FT_i$ : Import-Export share operated by city  $i$

$$\sum_i FT_i = 1$$

$c_{ij}$ : General transportation time between city  $j$  and city  $i$  by road.

$\gamma$ : Parameter

After an expressway was constructed, the change of accessibility to the outside would be as follows:

$$\begin{aligned} \Delta Acc &= A_{cc}^1 - A_{cc}^0 \\ &= \sum_{j=1}^N \sum_{i=1}^N P_j^1 FT_i^1 f(c_{ij}^1) - \sum_{j=1}^N \sum_{i=1}^N P_j^0 FT_i^0 f(c_{ij}^0) \end{aligned}$$

$\Delta Acc$ : the change of accessibility to the outside.

1,0 respect the situation with and without expressway respectively.

##### (2) The Accessibility between Cities in this Region

$$Acc_i = \sum_{j=1}^N Y_j Y_i f(c_{ij})$$

$Acc_i$ : Accessibility of city  $i$  to other cities

$Y_i, Y_j$ : Gross production values of industry and agriculture in city  $i, j$

$c_{ij}$ : General transport time from city  $i$  to city  $j$  by road.

$$Acc' = \sum_{i=1}^N Acc_i$$

$Acc'$ : The total value of the Accessibility among cities in the region.

##### (3) The Regional Attractiveness for Foreign Investment

According to the above analysis, the region's attractiveness for foreign investment is at positive proportion with its accessibility. We define the accessibility as the region's attractiveness for foreign investment. The model is as follows.

$$Att = (Acc + Acc'), \quad \Delta Att = A_{tt}^1 - A_{tt}^0$$

$Att$ : The attractiveness of this region for Foreign Investment

$\Delta Att$ : The change of  $Att$ .

$$\Delta Z = \Delta Att \times Z^0$$

$Z$  is the foreign investment in this region,  $\Delta Z$  is the change of foreign investment caused by the expressway's construction.

$$Z^1 = Z^0 + \Delta Z$$

#### 4.2. Modeling the Distributing Effect of Expressway on Foreign Investment

As the locating sites became more and more, the foreign investments didn't concentrate mainly in coastal cities as before. They would choose the location where they can get the maximum utility based on Random Utility Theory.

Hereafter the foreign investment location factors are supposed as follows.

- ⊗ Transportation convenience to the outside, it is represented by the transport time  $T$  from a city to the harbors.
- ⊗ The city's infrastructure condition: it is represented by the road length per capital  $D$  and telephone number/1000 persons  $E$
- ⊗ Land price and wage: they are represented by  $W$  and  $R$  respectively
- ⊗ The condition of the cities' industry and service level: they are represented by the second and third industry's production values  $O_2$   $O_3$  respectively.
- ⊗ Labor resource: it is represented by the population within the working age /employed population  $L$ .
- ⊗ Dummy factor  $\beta$  : if the city is self-planning one  $\beta = 1$ , otherwise  $\beta = 0$

The location activity of foreign investment:

$$MAX : \pi_i = Q_i - C_i$$

$$S.T. \quad C_i \leq I_i$$

$C_i$ : Locating and Producing cost;

$I_i$ : The capital invested to city  $i$ .

$Q_i$ : Production Value of Foreign Enterprises in City  $i$

Because the imported investment in a region is exogenous in 4.1, it can be said that the maximum profit means the maximum production. The production function is give as follows.

$$\begin{aligned} Q_i &= F(T_i, D_i, W_i, R_i, O_{2i}, O_{3i}, S_i, L_i, \beta_i) \\ &= \alpha_{1i} T_i + \alpha_{2i} D_i + \alpha_{3i} L_i P_i + \alpha_{4i} W_i + \alpha_{5i} R_i + \\ &\quad \alpha_{6i} O_{2i} + \alpha_{7i} O_{3i} + \alpha_{8i} L_i + \alpha_{9i} \beta_i + \varepsilon_i \end{aligned}$$

Because we suppose that foreign investors choose their location according to Random Utility

Theory, the capital invested to each city can be thought as having gained maximum production. So the probability of investing in city  $i$  can be calculated by Logit Model.

$$P_i = \frac{\exp(\mu Q_i)}{\sum_{j=1}^N \exp(\mu Q_j)} \quad \text{and} \quad Z_i = P_i \cdot Z^1$$

$Z_i$  is the foreign investment invested in city  $i$ .

$$\Delta Z_i = Z_i^1 - Z_i^0$$

$\Delta Z_i$  is the difference of foreign investment in city  $i$  between the situations with and without expressway.

#### 5. Conclusion and Further Works

We analyzed expressway's effects on foreign investment in this study. We divided these effects into two kinds, namely generation and distribution Effects. We also pointed out that generation Effect is caused by the increment of regional total accessibility and distribution Effects is resulted from increment of accessibility between cities in the improved region. In this study considering the data limitation, we developed the effects estimating models based on single-equation approach. In order to complete this study, our further works are to input data for simulating, and with its results to prove the correctness of this model. As a continuing study we will develop other models accompanied with this model to estimate the total effects of 'expressway' on the improved region in China.

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