1. Study on the Impacts of Transport Infrastructure on Economic Development in China
中国における交通インフラの経済発展への影響に関する研究

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The present study investigates into the relation between transport infrastructure and economic development in China. Based on review of existing studies and summary of China's development policy and history, a VAR model, a production function model and a SCGE model are used to examine the causality, magnitude, and regional difference of the impacts of transport infrastructure. It is found the transport infrastructure has triggering effect on economic development, which is featured by regional economic structure, geographic condition and the demand-supply situation of transport infrastructure, and the potential reverse causality may also exist. It is also concluded that the transport infrastructure has contributed to the widening gap between regions and the current transport infrastructure construction trend might not be very effective in promoting more balanced regional development in future.

1. Introduction

1.1 Background of China's Development

Since the 1980s, China has been transiting into a market-based economy from planned economy. The government policies favored the east coastal areas with privileges in export and import, natural resources etc. As a result, the development gap between the east part and mid-west part regions emerged and has been widening. The government's policy stimulus to cope with this gap turns out to be not very effective. Transport infrastructure investment is also seen as a way to trigger the development of inland regions. From the 1990s, the investment in infrastructure has been raised as a national policy priority. As a result, China has been spending huge amount of annual budget on transport infrastructures. And this trend is still going on with the steady support of the national plan. But still the infrastructure distribution shares a similar pattern as the economic growth that the infrastructure density and quality of east coastal areas are higher

1.2 National Development Policy

The national development policy of China has been following the "two overall strategies" by Deng Xiaoping to achieve a development goal of common prosperity. The historic flow of development policies reflects this concept that the policy support gradually moves from east coastal region to central and west inland regions. The regional industry policy works along with the strategy with knowledge and technology intensive industries of high-added value in east coastal regions and labor intensive industries of resource and energy in central and west regions. The economic development policies are also usually associated with corresponding infrastructure development policies.

At the meanwhile, the national investment also gradually changes its focus from the east to the west, causing a decrease in the share of investment in east region and an increase in central and west region. The share of private (domestic) investment in east region also on the whole decreases, but after 2000, there is not much change. While foreign investment always keeps a highest share in east region and even a decreasing share in west region.

Generally the development goals of economic growth are achieved for all regions in each plan period except when financial crisis causes a huge negative influence, while the goals of transport infrastructure development are fulfilled for all regions in every period despite the influence of financial crisis. The actual achievements compared to planned goals for coastal regions are usually larger. But along with the plans, the northwest and southwest regions are chasing up in economic growth speed while the growth speed of coastal regions is relatively slowing down, though the absolute gap is still widening.

2. Literature Review

Though there are many empirical evidences of a parallel relation between transport infrastructure and economic performance, the triggering effect of transport infrastructure on economic growth is found to be conditional. It has been concluded that crucial factors like economic vitality, industry structure, play a more important role in economic development. Transport infrastructure serves more as a necessary condition for the growth to occur.

The magnitude of the impact of transport infrastructure on economic growth varies from study to study, reflecting the complexity and difficulty in estimation. But a general positive effect has been confirmed by most researchers. With regard to the causality direction between the infrastructure and the economic growth, it appears to be ambiguous. It is generally confirmed that the infrastructure can trigger the economic growth. The reverse causality that economic growth induces infrastructure investment is in controversy.

The regional differences in the impact of transport infrastructure on economic growth are significant. The regional attributes in geographical location, industrialization level and urbanization level etc. are all likely to contribute to these differences. Also it is revealed in the previous research that the transport infrastructure in one region might have spillover effect on other regions. The effect could be positive or negative across the regions.

With regard to the case of China, most macro level results in magnitude and causality of the impact are consistent with previous research, i.e. a positive causal effect from transport infrastructure to economic growth. But most past research focus on single target, whole nation or one region, while the regional impacts of infrastructure is not sufficiently studied. Recent researches begin to study the regional impacts in China with different kinds of focus.

3. Research Objectives and Methodologies

Based on the research review, how significant the triggering effect of transport infrastructure on economic development could vary greatly. And how the impact of transport infrastructure varies among regions is not sufficiently considered in China's case. What's more, it is difficult to provide evaluation on practical projects, which is important for decision makers, by only macro relation analysis. The present study proposes 4 study objectives:

1. To testify the causality that transport infrastructure has promoting impact on economic development and to estimate the magnitude and significance of the impact.
2. To estimate the economic promoting impacts of transport infrastructure in different regions and investigate into the differences to find the connection to the regional disparities.
3. To examine the relation or connection between regional features and the difference in the impacts of transport infrastructure.
4. To evaluate the infrastructure construction trend to see if it will promote a balanced regional development in terms of welfare distribution.

Through a survey over the methodologies adopted in previous researches and with the consideration of the data requirement for different kinds of models and the data availability, the present study propose an application of three models to achieve the proposed objectives.

The data oriented VAR approach is used to examine the causality between transport infrastructure and economic growth as well as to give a picture of how the economic growth and input factors influence each other in a symmetrical framework.

The production function model is employed especially to derive the contribution of transport infrastructure on economic growth for each region, which reflects the regional differences in the impacts. The relation between regional features and the impact differentials are also to be discussed.

The SCGE (spatial computable general equilibrium) model is used to evaluate the spatial economic impacts of future national expressway network to demonstrate the possible impacts brought by the transport infrastructure construction trend. It is specifically focusing on the welfare distribution change caused by the transport network improvement.

4. Summary of VAR model

A restricted VAR model is first applied to check the causality and to give a rough illustration on the impacts of transport infrastructure on economic growth at national level. Four endogenous variables are used, the annual national GDP, the total gross capital stock K, the transport infrastructure capital G (including highway, waterway and railway data) and labor in employment L.

The time series is from 1985-2004 for all variables. No exogenous variable is used in the analysis. Based on the unit-root tests and cointegration test of the series, logged value of data is used and a Vector Error Correction (VEC) method is adopted with cointegration rank 3 and lag 1. Table 1 shows the estimate results.

Table 1 VEC estimate results

	D(LNG)	D(LNGDP)	D(LNK)	D(LNL)
CointEq1	0.053604	0.133891	0.086725	-0.2462
CointEq2	0.801333	-0.82389	-0.25336	0.54562
CointEq3	-1.02215	0.368175	0.037576	-0.037
D(LNG(-1))	-0.78746	-0.06512	-0.04566	0.138795
D(LNGDP(-1))	-3.11145	0.133749	0.01864	-0.50115
D(LNK(-1))	3.857521	1.105351	0.988202	-1.34549
D(LNL(-1))	-0.89833	-0.39724	-0.19563	-0.27167
C	0.120962	-0.01971	0.01096	0.198127
R-squared	0.863362	0.833436	0.789543	0.897175
F-statistic	9.026568	7.148142	5.359379	12.46471

With the estimates of VEC, impulse response analysis is done. It is found that one shock in the transport infrastructure G, the response of GDP converges to a certain level in a long term, which implies that an infrastructure shock could cause a relatively significant GDP increase in short-term while the additional impact on long-term is relatively smaller, which makes the accumulation of the lasting impacts moderate. Also variance decomposition analysis is done to separate the variation in GDP into the component shocks. It is found that transport infrastructure counts for a significant part of the GDP increase (15%-20%).

Granger test is used to examine the causality between infrastructure and economic growth. Considering that there are not enough observations for each variable and long lag intervals may also affect the results, an intermediate lag of 4 is used. The result of Granger causality test is shown in table 2. The hypothesis that G does not cause GDP growth is rejected at 1% level. While the hypothesis that GDP growth does not cause transport infrastructure cannot be rejected at 5% level but is rejected at 10% level. This shows the causality direction is more likely to be from transport infrastructure to economic growth. But the reverse causality cannot be denied.

Table 2 Cranger test results

Null Hypothesis:	lag	F-Statistic	Probability
G does not Granger Cause GDP	4	14.5173	0.00168
GDP does not Granger Cause G	4	3.93276	0.05546

5. Summary of Production Function Model

5.1 Model Specification and Data

A Cobb-Douglas form production function with an additional input factor G for transport infrastructure is adopted in this study. This is also mostly used form in previous studies with production function model, as is shown below.

$$P = AL^{\alpha}K^{\beta}G^{\gamma} \tag{1}$$

$$A = A_0 e^{\lambda t} \tag{2}$$

Where P represents the output; A represents the total factor productivity; L represents for labor input; K represents the capital input other than transport infrastructure; G is the transportation infrastructure input; α, β, γ are the parameters of input factors which reflect their output elasticity. The total productivity factor A represents the technique development over time, and the technique progress is assumed to be increasing constantly with respect to time. A_0 is a basic technique efficiency at base year; λ is the technical progress parameter; t is the time variable (year).

Fig.1 Region division

Firstly a region division of the country is made as shown in Fig. 1. Generally the division follows the same way of the multi-regional input-output table 2000 for China. There are 8 regions: northeast (NE), north coast (NC), north municipalities (NM), central coast (CC), south coast (SC), central (CN), northwest (NW), southwest (SW). The north municipalities (Beijing and Tianjin) and the north coast region here are combined into one, which is also named as north coast region, because the north municipalities region contains only two mega cities and it is inside the north coast region. However, later for the SCGE model 8 regions are used according to the origin input-output table structure.

After checking the data availability and suitability, the indicators are chosen for each variable. Table 3 shows the indicators and their data source.

Table 3 Indicator Choice and Data Source

Time span	1985-2004, 20 observations for each of region	
Variable	Indicator	Source
P	Real annual GDP	Statistic yearbook of China
L	Population in Employment	Statistic yearbooks of 31 provinces and municipalities
K	Gross capital stock other than transport infrastructure	Gross capital stock, highway and waterway data from estimate result from literature; Railway data from fixed assets yearbook of China
G	Transport Infrastructure capital stock	

5.2 Tests for Return to Scale

In traditional production function where only labor and capital are input factors, usually it is assumed there is constant return to scale. After introducing transport infrastructure factor, it is desirable to test whether this condition holds. Firstly regression is done under no constraint for all regions using equation (3), which is derived by taking logarithm on both sides of equation (1) with substitution of equation (2)[1].

$$\ln P = \ln A_0 + \lambda t + \alpha \ln L + \beta \ln K + \gamma \ln G \qquad (3)$$

Secondly, by the condition that production function is under a constant return to scale of all input variables, the elasticity parameters yield the following relation:

$$\alpha + \beta + \gamma = 1 \qquad (4)$$

[1] The results for each region are not listed for space reason.

The model is then examined under constant return to scale of all its input factors, with equation (5):

$$\ln P - \ln K = \ln A_0 + \lambda t + \alpha(\ln L - \ln K) + \gamma(\ln G - \ln K) \qquad (5)$$

Then Null hypothesis H_0 is set as there is constant return to scale while the Alternative hypothesis H_1 is set as there is no constant return to scale. The two hypotheses can be expressed as follows:

H_0: constant return to scale, $\alpha + \beta + \gamma = 1$

H_1: not constant return to scale, $\alpha + \beta + \gamma \neq 1$

F statistic is used for the test, which is derived by the following equation (6)

$$F = \frac{(RSS(H_0) - RSS(H_1))/p}{RSS(H_1)/(n-k-1)} \qquad (6)$$

Where RSS is the residual sum of squares of every region of each hypothesis; p is the number of constraint imposed, which is 1 in the present case; n is the number of observations, 20; k is the number of explanatory variables, 4. Table 4 shows the results for each region.

Table 4 Test results for CRS

	$RSS(H_0)$	$RSS(H_1)$	F-statistic
NE	0.006421	0.004061	8.717065
NC	0.021178	0.021019	0.113469
CC	0.041033	0.030698	5.050199
SC	0.01057	0.004055	24.10099
CN	0.016747	0.016736	0.010128
NW	0.001413	0.001390	0.255847
SW	0.005708	0.005706	0.005363

From above, it is shown that for northwest, north coast, central, southwest region, H_0 is accepted at 60%, 70%, 90% and 95% level, which shows the constant return to scale condition is not invalid. But for some regions, northeast, central coast and south coast, H_0 is rejected at 5% level, which shows some incompatibility with the assumption. However, the model results of northeast, central coast and south coast all contain some unrealistic values such as negative output elasticity of labor, which may be caused by the limited sample size. Thus, considering the overall situation above, the constant return to scale assumption is employed for all regions to examine the regional differences in the present study.

5.3 Estimate with Elasticity of Labor Calibrated

The model estimates above are not so desirable with insignificant results and questionable value of parameters. In order to improve the regression results and also for giving more comparative information for the model performance, some of the parameters are calibrated with other data under some assumptions of macroeconomic theories, but at the meanwhile, imposing additional constraints to the model besides constant return to scale.

Assuming perfect competition, α , β , γ can be shown to be labor, gross capital (exclusive of transport infrastructure) and transport infrastructure capital's share of output. For β , γ there is no available data to calibrate, but for α , one way is to utilize the income approach GDP (or GDI). It gives data of compensation of employees, which could be used as the labor's income. Table 5 shows the calibrated α for each region, which are relatively stable within each region but with some differentials between regions. The average values are used for model estimatation.

Table 5 Calibration of α

α	NE	NC	CC	SC	CN	NW	SW
average	0.495	0.483	0.457	0.495	0.587	0.574	0.574

A little different from the above calibration method, a calibration based on output method production account (added value) from input-output table also can be used. As a comparative case, α is calibrated as a national average result of 0.59

Then the model is estimated with equation (7):

$$\ln P - \alpha \ln L - (1-\alpha)\ln K = \ln A_0 + \lambda t + \gamma(\ln G - \ln K) \qquad (7)$$

Usually, it is common to apply regression for all parameters simultaneously. To calibrate α is based on the unsatisfactory result of regression with all parameters. This kind of partial regression can be found in some studies, though not very common. Compromising to the data limitations, the estimate is done with α calibrated.

Table 6 shows the output elasticity of transport infrastructure under three different assumptions as well as the share of transport infrastructure in gross capital stock for each region. Generally, all estimate results are all between (0.1~0.3), which is a common space of results from previous work. Moreover, the output elasticity of transport infrastructure is roughly negatively related to the share of transport infrastructure in gross capital stock for the coastal regions. The output elasticity of northeast and central region is also relatively high though the share of transport infrastructure to total capital stock is not quite small. For the southwest and northwest regions, though their share of transport infrastructure to total capital stock is of same scale to that of central and northeast region, the output elasticity is much smaller.

Table 6 Output elasticity of transport infrastructure

Region	output elasticity of transport infrastructure			Share of transport infrastructure in gross capital stock
	Non-Calibratoin	Regional specific α	Common α	
northeast	0.235	0.208	0.253	0.100
north coast	0.166	0.199	0.213	0.072
central coast	0.271	0.281	0.272	0.044
South coast	0.210	0.236	0.261	0.058
central	0.219	0.248	0.250	0.067
northwest	0.114	0.134	0.137	0.117
southwest	0.146	0.123	0.101	0.072

6. Summary of SCGE model

6.1 Model Assumptions and Structure

The general framework of the SCGE model is illustrated in figure 2. It describes the operational mechanism of social economy under the following assumptions:

1. The nation is divided into S regions, and there is a representative household in each region;
2. For each region there are J productive sectors, and each sector is supposed to produce a representative type of goods;
3. It is assumed that the goods from same type of productive sector but in different regions are treated as different goods in consumption and intermediate input. (Armington assumption)
4. Transport cost occurs with the consumption of goods, which is assumed to be an additional consumption of goods provided by correspondent productive sector. (Iceberg type transport cost assumption)
5. The factors of production are labor and capital stock, which are assumed to be owned by the local household and fixed for each region in this model. While the goods market are free and open for all regions.
6. All markets are assumed to be perfectly competitive and in long term equilibrium status.

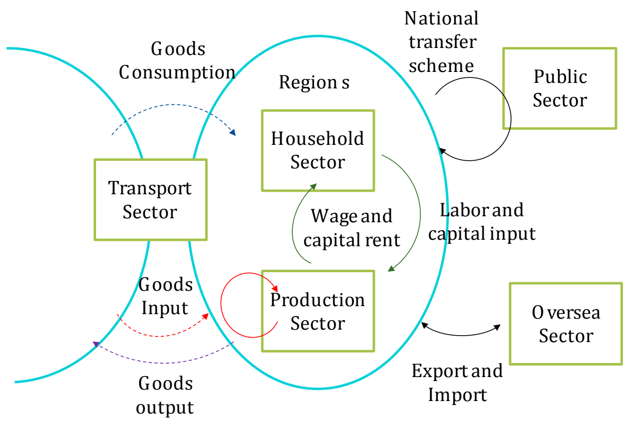

Fig.2 The SCGE model structure

6.2 Household Behavior Model

The household of each region is assumed to maximize its own utility by choosing an optimal combination of consumption goods under the constraint of its income. A Nested-CES type utility function is assumed for the household, as is shown in figure 3.

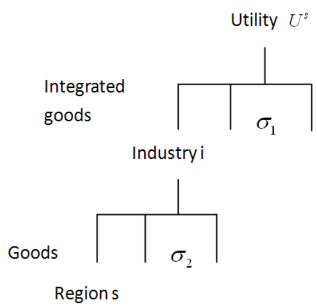

Fig.3 Hierarchy of household utility

In the first layer, the household tries to maximize its utility by choosing an optimal consumption combination of integrated goods under its income constraint. The behavior can be formulized by equations (8):

$$V^s = \max_{f_i^s} U^s\left(f_1^s,\cdots,f_i^s\right) \qquad (8\text{-}1)$$

$$s.t. \sum_{i\in I} PF_i^s f_i^s = w^s L^s + r^s K^s - NX^s$$

(8-2)

$$U^s = \left(\sum_{i\in I}\gamma_i^s f_i^{s\frac{\sigma_1-1}{\sigma_1}}\right)^{\frac{\sigma_1}{\sigma_1-1}} \qquad (8\text{-}3)$$

Where V^s is the indirect utility function; U^s is the direct utility function; f_i^s is the consumption of integrated goods i in region s; L^s is the labor input in region s; K^s is the capital input in region s; PF_i^s is the price of the integrated goods i in region s; w^s is the wage rate for labor input; r^s is rent rate for capital input; NX^s is the income transfer in region s; σ^1 is the elasticity of substitution; γ_i^s is a share parameter.

With the optimal consumption amount of integrated goods given by equations (8), the household then minimizes its cost by choosing an optimal combination of goods from different regions. This is the second layer of the utility maximizing process which can be formulated with equation (9):

$$\min_{f_i^{rs}} \sum_{r\in R}(1+t^{rs})p_i^r f_i^{rs} \qquad (9\text{-}1)$$

$$s.t.\ f_i^s = \psi_i^s\left(\sum_{r\in R}\gamma_i^{rs} f_i^{rs\frac{\sigma_2-1}{\sigma_2}}\right)^{\frac{\sigma_2}{\sigma_2-1}} \qquad (9\text{-}2)$$

Where t^{rs} is a transport mark-up rate; P_i^r is the production price of goods i in region s; f_i^{rs} is the consumption of goods i from region r by household of region s; ψ_i^s is a conversion factor; σ^2 is the elasticity of substitution; γ_i^{rs} is a share parameter.

6.3 Productive Sector Behavior Model

A Nested-CES type production function model is used to describe the production process as is shown in figure4.

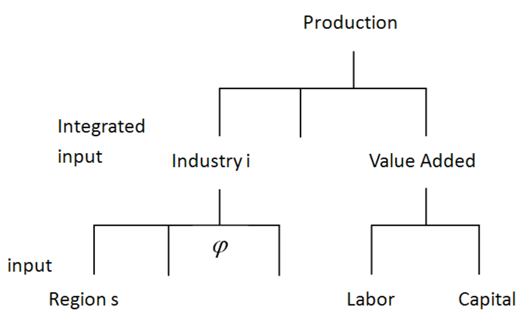

Fig.4 Hierarchy of production function

A Leontief type production function is used for integrated goods input and value added input, which yields the form of

$$X_j^s = \min\left(\frac{VA_j^s(l_j^s,k_j^s)}{a_{0j}^s}, \frac{x_{1j}^s}{a_{1j}^{ts}}, \frac{x_{2j}^s}{a_{2j}^{ts}}, \cdots, \frac{x_{ij}^s}{a_{ij}^{ts}}\right) \qquad (9\text{-}1)$$

$$VA_j^s(l_j^s,k_j^s) = \eta_j^s l_j^{s a_j^s} k_j^{s(1-a_j^s)} \qquad (9\text{-}2)$$

Where X_j^s is the output of production sector j in region s; l_j^s is the labor input of production sector j in region s; k_j^s is the capital input of production sector j in region s; x_{ij}^s is the integrated intermediate goods input of production sector i to production sector j in region s; VA_j^s is the added value of production sector j in region s; a_{ij}^{ts} is the input coefficient including Iceberg transport cost; a_{0j}^s is the value added ratio of production sector j in region s; α_j^s is the share parameter of labor input; η_j^s is the efficiency parameter.

The optimal combination of intermediate goods input from different regions and production sectors is derived by solving the following cost minimization problem.

$$\min_{x_{ij}^{rs}} \sum_{r\in R}(1+t^{rs})P_i^r x_{ij}^{rs} \qquad (9\text{-}3)$$

$$s.t.\ \ x_{ij}^s = \phi_{ij}^s \left(\sum_{r\in R} \beta_{ij}^{rs} x_{ij}^{rs\,\frac{\varphi-1}{\varphi}} \right)^{\frac{\varphi}{\varphi-1}} \qquad (9\text{-}4)$$

Where x_{ij}^{rs} is the intermediate goods input from production sector i of region r to production sector j of region s; Φ_{ij}^s is conversion factor; β_{ij}^{rs} is the share parameter; φ is the elasticity of substitution.

6.4 Equilibrium Condition

In the long term equilibrium status, all markets are cleared out in terms of supply and demand, which yields the following equations.

$$X_i^r = \sum_{s\in S}\sum_{j\in J}(1+t^{rs})x_{ij}^{rs} + \sum_{s\in S}(1+t^{rs})f_i^{rs} + EX_i^r + IM_i^r + Q_i^r \qquad (10\text{-}1)$$

$$\sum_{j\in J} a_{0j}^s X_j^s \frac{a_j^s}{w^s}\frac{1}{\eta_j^s}\left(\frac{w^s}{a_j^s}\right)^{a_j^s}\left(\frac{r^s}{1-a_j^s}\right) = L^s \qquad (10\text{-}2)$$

$$\sum_{j\in J} a_{0j}^s X_j^s \frac{1-a_j^s}{w^s}\frac{1}{\eta_j^s}\left(\frac{w^s}{a_j^s}\right)^{a_j^s}\left(\frac{r^s}{1-a_j^s}\right) = K^s \qquad (10\text{-}3)$$

6.5 Scenario Setting

Expressway network and railway network are chosen as the representative transport infrastructure because of their vast space coverage and network characteristic. Two specific scenarios, the current and the future, are set for the evaluation. Since there is no available annual network data in this case, so some approximation is made. For the expressway network, the national artery highway network plan (issued in 1993) is used as the current scenario. The national expressway network plan (issued in 2004) is used for future scenario. As to the railway network, since the topology does not change much in the past decades and there is not much data, it is assumed to be fixed.

Since there is no data on interregional freight traffic flow, the simplest indicator of shortest path is used to represent the transport impedance between regions, and the change in shortest path represents the improvement in highway network. Two expressway networks for current and future scenario are built as below (fig. 5). Then for each region a representative city, capital city and transport hub, is chosen as the centroid of the region.

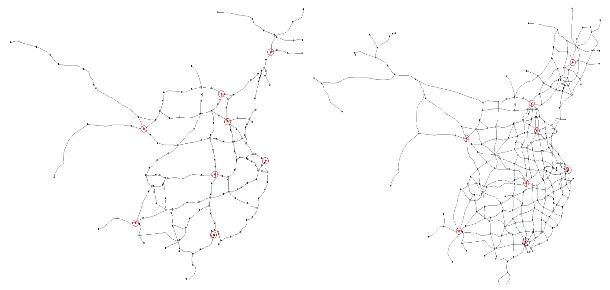

Fig.5 Current (left) and future (right) scenario

Then, two sources of transport cost (highway and railway) are separated. Without any detailed data on the share of freight flow transported by highway and railway, it is assumed there is a constant proportion for all pairs of freight flow. And this proportion is assumed to be the same as that of freight ton-kilometers for highway and railway, which is around 0.3:0.7 (highway to railway).

According to national regulations on transport fare, the cost of freight transport is approximately proportionate to the weight and distance transported. However, the weight/price of goods transported data is unavailable. Hereby it is assumed that in all regions the cost of transport 1unit km is the same for railway and highway respectively. And with the real freight ton kilometer data and approximate average price (0.4 yuan/km ton for highway; 0.0775yuan/km ton for railway) the total transport cost can be derived for railway and highway respectively.

Then by assign this total cost to each pair of region flow, proportional to the product of monetary flow volume and shortest path length, the transport margin matrix for current scenario can be derived (Table 7). In the future scenario, the transport cost is reduced proportional to the shortest path length reduction. Based on this the transport margin matrix for future scenario is derived. (Table 8)

Table 7 Transport margin for current scenario

Current	NE	NM	NC	CC	SC	CN	NW	SW
NE	0.0060	0.0140	0.0114	0.0176	0.0226	0.0239	0.0267	0.0427
NM	0.0089	0.0011	0.0041	0.0087	0.0140	0.0095	0.0141	0.0206
NC	0.0099	0.0050	0.0038	0.0062	0.0126	0.0083	0.0113	0.0183
CC	0.0144	0.0090	0.0057	0.0029	0.0102	0.0073	0.0158	0.0168
SC	0.0210	0.0148	0.0125	0.0102	0.0037	0.0083	0.0189	0.0152
CN	0.0187	0.0152	0.0128	0.0081	0.0085	0.0067	0.0121	0.0136
NW	0.0513	0.0241	0.0183	0.0233	0.0228	0.0172	0.0140	0.0242
SW	0.0302	0.0273	0.0262	0.0188	0.0139	0.0182	0.0179	0.0107

Table 8 Transport margin for future scenario

Current	NE	NM	NC	CC	SC	CN	NW	SW
NE	0.0060	0.0131	0.0114	0.0155	0.0218	0.0232	0.0257	0.0424
NM	0.0081	0.0011	0.0041	0.0084	0.0139	0.0095	0.0134	0.0205
NC	0.0099	0.0050	0.0038	0.0060	0.0120	0.0070	0.0105	0.0172
CC	0.0123	0.0087	0.0053	0.0029	0.0093	0.0064	0.0151	0.0167
SC	0.0201	0.0148	0.0118	0.0093	0.0037	0.0077	0.0164	0.0128
CN	0.0180	0.0152	0.0116	0.0072	0.0079	0.0067	0.0102	0.0131
NW	0.0504	0.0234	0.0174	0.0227	0.0203	0.0154	0.0140	0.0213
SW	0.0299	0.0272	0.0251	0.0187	0.0115	0.0176	0.0150	0.0107

6.6 Simulation Results

Equivalent variation (EV) is used as the indicator for benefits.

$$EV^s = (w_0^s L^s + r_0^s K^s - NX^s)\left(\frac{U_1^s - U_0^s}{U_0^s}\right) \quad (11)$$

The simulation result is shown in table 9.

Table 9 Benefit distribution among regions

	NE	NM	NC	CC	SC	CN	NW	SW
EV	22460	7257	38422	60672	59486	67825	37359	37893

It is shown that the benefit due to the improvement of the transport network is positive in all regions. It is also found out that coastal regions gain more benefit than other regions. And the robustness of this result is confirmed with the sensitivity analysis on 3 author-assigned parameters, the elasticity of substitution.

7. Conclusion

The transport infrastructure does cause the economic development but the reverse causal link also cannot be rejected. And by summarizing 3 different models, it could be concluded that there is an economic growth triggering effect of transport infrastructure.

In one hand, the social investment, including private investment and national investment follows the national development plan and shares a same pattern in the past decades with great concentration in east coastal regions. In another, the government is always trying to facilitate certain economic development plans with corresponding infrastructure development plans with a relatively parallel relation in investment to infrastructure and economic industries. Then combined with the high output elasticity of transport infrastructure in east coastal regions, it may be concluded that the high investment in transport infrastructure in east coastal regions has partially lead to the regional gap widening.

From the angel of government financing, most local transport infrastructure investment is funded locally. This leads to a circulation that the transport infrastructure investment in more developed coastal regions brings about better economic output, which in return provides more resources for transport infrastructure investment, while the situation for the inland west regions is the opposite. In this sense, the transport infrastructure does play a part in the widening gap between coastal and inland regions.

It is also can be explained that regional economic structure, geographic condition and the demand-supply situation of transport infrastructure together features the regional impact of transport infrastructure. Transport infrastructure in more developed coastal regions is still in great demand, due to their fast economic development, which leads to a high output elasticity. Northeast and central regions' main industries are more sensitive to transport cost, which also makes them relatively high output elasticity. For west regions, the absolute amount of transport infrastructure is still very limited and geographic condition is poor, which leads to a lower output elasticity.

Combining implications of production function model and SCGE model, it might be concluded that the transport infrastructure, though has been playing a great role in promoting economic development nationwide, has partially led to and possibly will continue to contribute to the widening development gap between regions. Thus the strategy of helping less developed regions to catch up with developed regions with transport infrastructure might not be effective, at least in the current situation.