Quantitative Analysis of Location Externalities Considering Endogeneity Biases

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When making a location decision, a firm considers only its own trading costs and ignores trading costs paid by trading partner firms. The latter is the source of locational externalities. We examine this locational externality in the Tokyo metropolitan area, using the actual trade networks. Results show (1) we classify what trade patterns involve locational externalities, (2) the ratios of trade affected by and generating locational externalities as a percentage of total trade were 27% and 24%, respectively, (3) the transfer of a randomly-chosen 5% of firms to the center of Tokyo can generate external benefits of 0.71% in the total industry, 0.88% in the secondary industry, and 0.56% in the tertiary industry in terms of value added on average, and (4) the transfer of firms classified in "Transport and postal services", "Finance and insurance", and "Services, n.e.c" to the center of Tokyo can generate relatively large external benefits in terms of value added.

Key Words : *locational externalities, productivity, trade network*

1. INTRODUCTION

This paper analyzes agglomeration economies arising from location externality. Location externalities are technological externalities firms generated by their location selection arising from the existence of traffic and communication costs. For the first time, Kanemoto (1990)[1)] showed the existence of location externalities in case of bilateral trading. However, in reality, it is highly possible that trading between firms is unilateral rather than bilateral. Kono et al. (2019)[2)] showed that location externalities can occur if three or more firms are linked, even if not by bilateral trading.

By using micro data of firms in the Tokyo metropolitan area, this research tries to use actual data to confirm the frequency of trading patterns, and carry out a quantitative analysis of the scale of location externalities.

2. CLASSIFYING TRADING STRUCTURES OF FIRMS

Based on Ohnishi et al. (2010)[3)], we analyze which of trading patterns cause location externalities. When the firms' networks consist of sub-graphs of three nodes, there are thirteen kinds of network patterns and the types receiving location externalities shown in Figure1. The red nodes indicated by broken line represents the type receiving location externalities.

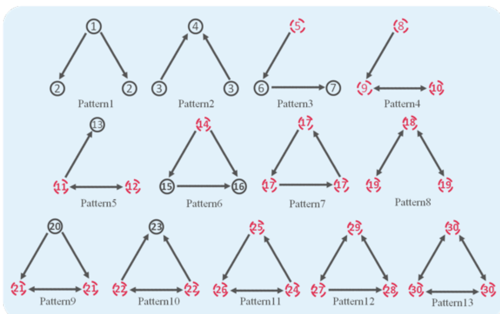

Figure1. Network patterns and trading types that receive location externalities (red)

Then, we analyze the frequency of each type of trading structure appearing in the networks among listed firms in the Tokyo metropolitan area. Listed firms were chosen according to the availability of data from their annual securities reports. As a result of the analysis, the ratio of trades that receives and generates location externalities as a percentage of total trade are 27% and 24%, respectively.

3. THE MODEL

The model can derive the following regression equation from a production function and a profit function

$$TFP_{h,y} = \sum_{j=1}^{J} \theta_{ij} \cdot \frac{\sum_{m=1}^{M_h} d_{hm,y}}{M_{h,y}} + v_h + \varepsilon_y \tag{1}$$

where θ_{ij} is the parameter for transport costs between headquarters of industries $i\ (h \in i)$ and $j\ (m \in j)$, $M_{h,y}$ is the number of firms in industry h in year y, v_h is unobserved time-invariant heterogeneities, which can control for the level of individual firm fixed effect, and ε_y is the error term that shows iid in year y.

The sign of θ_{ij}, which is the first term on the right side of eq. (1), should be negative, because an increase in trading costs associated with a greater generalized cost of transport reduces TFP.

4. PARAMETER ESTIMATES

Using eq. (1), the parameter can be obtained for a combination of the sectors which contain industries i and j from fixed effects regression analysis. The reason we use fixed effects regression is that endogeneity biases possibly exist. For parameter estimation, we set industry i (customer) × j (supplier) as 1) all industries × all industries, 2) secondary industry × secondary industry, 3) tertiary industry × tertiary industry, 4) tertiary industry × secondary industry, and 5) tertiary industry × tertiary industry. Table 1 shows regression results. Estimated parameters, θ, are negative in all combinations of i and j. That implies that a reduction in transportation costs of inputs increases the TFP.

Table 1 Regression results

j \ i	(1)	(2)	(3)	(4)	(5)	(6)
	All industries		Secondary industry		Tertiary industry	
Distance elasticity	t=1.0	t=2.0	t=1.0	t=2.0	t=1.0	t=2.0
All industries	-4.74E-04***	-6.01E-08**	-	-	-	-
	(8.51E-05)	(3.02E-08)				
Secondary industry	-	-	-2.30E-04**	-5.27E-08*	-8.23E-04***	-2.19E-07***
			(8.90E-05)	(2.71E-08)	(1.66E-04)	(5.03E-08)
Tertiary industry	-	-	-1.45E-04	-1.99E-10	-8.63E-04***	-2.47E-07***
			(9.55E-05)	(1.22E-08)	(1.78E-04)	(6.26E-08)
R-squared	0.932	0.930	0.931	0.931	0.914	0.911
Number of observati	1672		796		876	

Cluster robust standard-errors in parentheses. *significant at 10% level, ** significant at 5% level, ***significant at 1% level.
$E-n$ means $\times 10^{-n}$.

5. CALCULATING LOCATION EXTERNALITIES

Using the parameters shown in Table 1, we carried out two counterfactual simulation analyses in the following steps.

In CASE_1, we target three sets of firms: the first case is all firms (i.e., 836 firms), the second case is the secondary sector firms (i.e., 398 firms), and the third case is the tertiary sector firms (i.e., 438 firms). Here, the Marunouchi 1-Chome (near Tokyo station) is considered as the center of the Tokyo metropolitan area. As the main objective is to analyze the changes in productivity arising from locational externalities, we do not consider firms' transfer costs such as construction costs of new buildings.

The steps for the simulation case are shown below:

1) Move 5% of firms randomly extracted from target firms to the center of the Tokyo metropolitan area (Marunouchi 1-Chome).
2) Recalculate the trading costs among firms.
3) Recalculate $TFP_{h,y}$ based on eq. (1) with the new trading costs.
4) Calculate the value added by the renewed TFP.
5) Repeat STEP 1) to STEP 4) 5000 times.

Table 2 shows the results from step 1) to 5). when 5% of the 836 firms move to the center of the Tokyo metropolitan area, generate external benefits of 0.71% in the total industry, 0.88% in the secondary industry, and 0.56% in the tertiary industry in terms of value added on average.

Figure 2 shows the frequency of changes in the all sector case in the 5000 simulations. Almost all of the results are located in the positive region both in cases t = 1.0 and t = 2.0. Thus, the relocation of firms generates significant positive locational externalities for non-moved firms.

Table 2 Simulation result

(Unit : JPY Trillion)

		(1)	(2)	(3)	(4)	(5)	(6)
		All industries		Secondary industry		Tertiary industry	
		t=1.0	t=2.0	t=1.0	t=2.0	t=1.0	t=2.0
Value added before relocation		22.5					
Changes in value added of non-moved firms	Average (a)	0.159	0.076	0.198	0.117	0.125	0.044
	%	0.71	0.34	0.88	0.52	0.56	0.20
	Max	0.766	0.634	0.566	0.279	0.910	0.650
	%	3.40	2.82	2.52	1.24	4.05	2.89
	Min	-0.115	-0.030	-0.063	0.007	-0.141	-0.053
	%	-0.51	-0.13	-0.28	0.03	-0.63	-0.23
Changes in value added of moved firms	Average (b)	0.090	0.050	0.074	0.041	0.112	0.059
	%	0.40	0.22	0.33	0.18	0.50	0.26
Externalities for non-moved firms/ moved firms own	ratio (a/b)	1.76	1.54	2.69	2.88	1.11	0.75

Note : Max is a value showing high-order 5% of simulation data.
Min is a value showing low-order 5% of simulation data

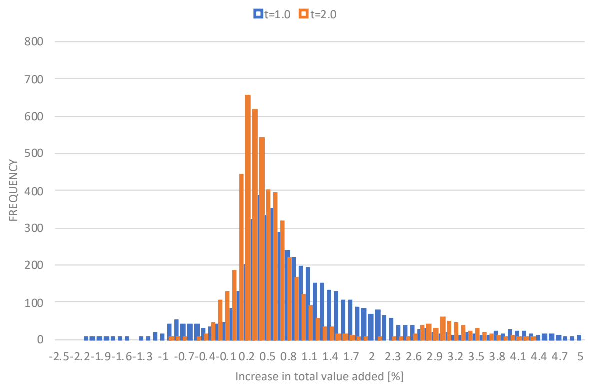

Figure2. the frequency of changes in the all sector case

In CASE_2, we choose firms divided into 20 types of industry and relocate them to Marunouchi 1-Chome (where Tokyo Station is located) as the center of the Tokyo metropolitan area by each industry. Then, we calculate the value added by the renewed TFP, and calculate only the externality part as well as STEP 4 in CASE_1.

The results show that "Transport and postal services", "Finance and insurance", and "Services, n.e.c" have larger locational externalities than other industries. Therefore, if these industries were located in the center of Tokyo, large external benefits would be expected.

6. CONCLUSION

In this research, we empirically estimate the size of the locational externalities generated by firm-to-firm trades in the Tokyo metropolitan area. These quantitative results show that locational externality should be considered for future industrial policies such as location subsidies or land use regulations.

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