Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

28-Sep-2015

English - Or. English

DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INNOVATION
COMMITTEE ON INDUSTRY, INNOVATION AND ENTREPRENEURSHIP

DSTI/IND(2015)11
For Official Use

CREATION OF AN OECD GLOBAL FORUM ON PRODUCTIVITY

Thursday 15 and Friday 16 October 2015

This draft document contains a proposed mission statement for an OECD Global Forum on Productivity.

Action: Delegates are invited to provide comments on the mission statement and approve it for submission to the External Relations Committee. It is also being submitted to the Economic Policy Committee and the Economic and Development Review Committee under their own respective codes.

Contact: Dirk Pilat, Deputy Director, Directorate for Science, Technology and Innovation
Tel: +33 1 4524 93 80, E-mail: dirk.pilat@oecd.org

JT03382590

English - Or. English

NOTE BY THE SECRETARIAT

1. A Global Forum[1] is a network or community of policy makers and other stakeholders in Member and Partner economies. Committees (one or more committees together) can use a Global Forum to identify relevant issues or to promote a convergence of views among a broad range of stakeholders. There is a wide range of options for resourcing such efforts. Global Fora are meant to deal with issues that defy solutions on a regional or country level and that benefit from participation beyond OECD membership.

2. This note proposes the launch of an OECD Global Forum on Productivity (hereafter the "GFP") along the lines of the draft mission statement reproduces in Annex. This proposal is the result of the "Global Dialogue on the Future of Productivity: Towards an OECD Productivity Network" discussions at a conference held in Mexico City on 6 and 7 July 2015 (hereafter the "Mexico Conference") on the basis of a revised concept note prepared by the OECD Secretariat [ECO/CPE(2015)2].

3. The GFP would aim to strengthen the OECD's global relations and fill knowledge gaps in the area of productivity, covering work by the Economic Policy Committee (EPC), the Committee on Industry, Innovation and Entrepreneurship (CIIE), and the Economic and Development Review Committee (EDRC). These three committees would be the "parent" bodies of the GFP, but this would not preclude the involvement of other committees in the work of the GFP in the future.

4. Serving as a joint global relations platform for these three committees in the area of productivity policy and research, the GFP will build on the OECD's multi-disciplinary expertise and work experience on productivity and benefit from the input of these committees, whose work has already generated substantial results in many countries.

Participation

5. The GFP would enable the three committees to involve the non-Members that do not have Participant or Associate status in their work, besides their Partners. In accordance with the Resolution of the Council on Partnerships in OECD Bodies [C(2012)100/FINAL], Participants and Associates of any of the three parent committees should be invited to all meetings of the GFP. Other attendees of GFP meetings will be invited at the Secretary-General's discretion, on the understanding that the parent committees are informed as early as possible, in advance of the meeting, about this intention.[2]

6. Participants would in particular include high-level government officials from Members and Partners globally, as well as designated international organisations and productivity experts. It is expected that countries and other participants that have expressed interest in the launch of the GFP, as well as its future participants, will help to support its ongoing viability, including financially.

Governance

7. It is proposed that a Steering Group of countries be set up to guide the work programme of the GFP. It would be important, considering the task of the Steering Group that participating countries be able and willing to provide their support, including financially, to the GFP. During the Mexico Conference and

1 C(2008)208/FINAL. See ERC(2014)15 for an overview of the OECD's experience with Global Forums.
2 See C(2008)208/FINAL, par. 16.

in bilateral communications, Australia, Brazil, Canada, Chile, Denmark, France, Germany, Italy, Mexico, New Zealand, Norway, Portugal, Romania, Sweden, Switzerland, Turkey and the United Kingdom expressed their interest to participate in the Steering Group.

Next steps

8. Once approved by the three parent committees, the External Relations Committee (ERC) would need to be notified of the launch of the GFP and its mission statement, and its Delegates will have the possibility to intervene within 15 days.

Proposed action

9. The Economic Policy Committee, the Committee on Industry, Innovation and Entrepreneurship and the Economic and Development Review Committee are invited to approve the launch of the GFP with the draft mission statement reproduced in Annex.

ANNEX
DRAFT MISSION STATEMENT OF THE OECD GLOBAL FORUM ON PRODUCTIVITY

Global Forum:	OECD GLOBAL FORUM ON PRODUCTIVITY
To be approved by:	Economic Policy Committee (29-30 October 2015) Committee on Industry, Innovation and Entrepreneurship (15-16 October 2015) Economic and Development Review Committee (2 December 2015)

Mission Statement:

The OECD Global Forum on Productivity (GFP) will provide a forum for mutual exchange of information and foster international co-operation between public bodies with responsibility for promoting productivity-enhancing policies, including in undertaking joint policy analysis. The GFP will provide an overall framework within which participants will convene to exchange views and discuss best practices. Specifically, it is envisaged that the GFP will:

- Hold an annual meeting (a Productivity Conference) to review recent analysis of productivity and related issues, as well as developments in policy and best practices by participants.
- Operate a dedicated website/portal for participants to exchange information on past, current and planned analysis, available data, events and initiatives around the productivity theme.
- Provide an "opportunity" platform for exchanging views, experiences and information, institutional and governance arrangements and government structures, with a view towards developing better policies.
- Organise, as appropriate and on a regular basis, additional policy or technical meetings or workshops on specific issues, ideally adjacent to the meetings of relevant OECD bodies.
- Undertake and support analytical work aimed at serving the policy needs of participants, complementing the OECD work programme.

The analytical work of the GPF will draw upon work already designated within the programme of work of bodies such as Working Party No. 1 on Macroeconomic and Structural Policy Analysis (WP1) of the Economic Policy Committee (EPC) and the Committee on Industry, Innovation and Entrepreneurship (CIIE). The GPF will then add to this by contributing related work from the various participants, as well as from outside academic and think-tank experts, as appropriate.

With participants' support, the GPF will extend this work through a well-prioritised and coherent stream of analytical work serving the policy research needs of participants on the drivers of productivity growth. The GPF will facilitate and promote joint efforts of participants in different areas related to productivity analysis and policy, generating synergies that are currently difficult to obtain.

Any analytical work will by design to be complementary to the OECD work programme. Outcomes will be shared and reported to the relevant OECD bodies, including as an input to the Economic and Development Review Committee (EDRC).

The Steering Group will guide the work of the GFP.

For Official Use **DSTI/IND(2015)12**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **15-Sep-2015**

English - Or. English

DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INNOVATION
COMMITTEE ON INDUSTRY, INNOVATION AND ENTREPRENEURSHIP

TRANSPORTATION INFRASTRUCTURE INVESTMENT AND THE LOCATION OF NEW MANUFACTURING: A KOREAN CASE STUDY

Thursday 15 and Friday 16 October 2015

This report has been prepared by Sanghoon Ahn (OECD Secretariat and KDI), Hyungtai Kim (Georgetown University and KDI) and Gudmundur F. Ulfarsson (University of Iceland). The authors wish to gratefully thank Statistics Korea for providing the data used in this study. The authors also thank Park Ji-Young for research assistance during data preparation and Hwang Cheol-Soo for preparing spatial data.

This paper contributes to the project on "Evaluation of the Effectiveness of Industrial and Innovation Policies"(1.2.1.3).

Action Required: Delegates are invited to provide comments on the paper. They may be requested to approve the paper for declassification.

Contact:
Structural Policy Division:
Mr Sanghoon Ahn, tel: +33 1 45 24 93 91; fax: +33 1 44 30 62 57; e-mail: sanghoon.ahn@oecd.org

JT03381701

English - Or. English

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Investment in transport infrastructure can be an important source of regional economic development. This study analyses the impact of the opening of the West Coast Expressway in Korea on the location of new manufacturing establishments near the road. The expressway opened in December 2001 and connects the Seoul Metropolitan area with Jeolla province. Major construction goals were to stimulate industrial development of nearby regions and improve the traffic flow around existing industrial complexes. The analysis uses panel data for the ten years of 1997 through 2006 developed from the annual Korea Mining and Manufacturing Survey and other sources. The analysis uses a fine spatial resolution based on three non-overlapping, small spatial administrative units: city *wards* (Korean: dong), *towns* (K. eup), and rural *districts* (K. myeon).

- The increased accessibility arising from the opening of the West Coast Expressway turns out to have a significant impact on the location decision of new manufacturing establishments regardless of technology level or size. Most new manufacturing establishments tend to choose a location near an interchange (IC) of the West Coast Expressway.

- The accessibility to the prior existing expressway is also found to have a statistically significant impact on the location of new manufacturing establishments. The overall results imply that when a manufacturing establishment decides on location, accessibility to the existing expressway is as important as the accessibility to the new expressway.

- The average wage of employed workers in local manufacturing establishments is also an important location determinant for new manufacturing establishments, especially of lower technology levels which are attracted to lower wages. Land price is found to produce a negative effect regardless of technology level or size.

- The number of employed workers in existing manufacturing establishments in the local area is a highly significant positive location determinant for new manufacturing establishments, indicating agglomeration effects. Clustering by technology level is an important location determinant for a new manufacturing establishment.

The opening of the West Coast Expressway has attracted new manufacturing establishments and contributed to the regional development and industrial progress of the west coast area of Korea. This area was underdeveloped and lagged behind the Gyeongbu axis's (Seoul-Busan) existing economic clusters. The results suggest this investment in expressways serves as an effective tool for regional economic development. This effect is stronger with agglomeration of existing industries and inter-sectoral clustering. Accordingly, if the goal of a new expressway is to promote regional development through industrial development, policy makers need to plan the route and ICs of a new expressway with agglomeration in mind. It is necessary to link to existing economic clusters and take planned industrial locations into account.

Keywords: Transportation infrastructure; Investment; Location choice; Firm birth; Economic development; Social overhead capital.

TRANSPORTATION INFRASTRUCTURE INVESTMENT AND THE LOCATION OF NEW MANUFACTURING: A KOREAN CASE STUDY

1. Introduction

1. Given the immense expenditures associated with major transport infrastructure construction, it is important to investigate the impacts on regional economic development. The importance of transportation cost and accessibility in the location decision of firms has been emphasized for a long time since Weber (1929) established a model for cost minimization or profit maximization.

2. Generally, transportation infrastructure investment is positively correlated with economic growth although the effects can vary considerably in size or significance. For instance, Song and van Geenhuizen (2014) show that investment in port infrastructure in China has contributed to increased regional economic growth. Studies at the national level in the US have shown a positive correlation between infrastructure capital, specifically expressways, and productivity (Aschauer, 1989; Fernald 1999). A positive correlation has been found to exist between transport infrastructure and output (Conrad and Seitz, 1994; Boarnet, 1998). Coughlin and Segev (2000) find that the level of transport infrastructure has a positive correlation with the number of new foreign-owned manufacturing establishments. The time-series analyses of Holl (2004a, 2004b) show that the expansion of transport infrastructure has a statistically meaningful correlation with the new entry of manufacturing establishments.

3. High-speed rail investment has been found to improve local budgets although on the national scale the investment may not pay off and can require subsidies (Hernándes and Jiménez, 2014). A positive effect of railway stations has been found in the stations' vicinity based on UK and Spanish data (Mejia-Dorantes and Lucas, 2014) and on the entry of corporate offices at the US census tract level which along with accessibility to expressway have been found important for the decision of firm location (Ihlanfeldt and Raper, 1990).

4. Among studies dealing with the relationship between transport infrastructure and employment growth through geographically disaggregated data, Luce (1994) and Singletary et al. (1995) found a positive correlation, whereas Bollinger and Ihlanfeldt (1997) suggest a negative correlation. In this way, preceding studies on aggregate economic effects have produced conflicting results.

5. Taken together, most regional-level studies focusing on the aggregate effect of transport infrastructure show positive impacts, but in the absence of geographically disaggregated data, inter-metropolitan analyses cannot accurately measure the impact of transport infrastructure. A recent meta-analysis of 33 transportation investment studies found the positive effect is generally greater in sectors such as manufacturing and that the effect varies between the US and Europe (Melo et al., 2013).

6. Only a limited number of studies on this topic have been conducted in Korea due to difficulty in gathering data and a huge volume of unsorted data. Of the few studies on transport infrastructure, there is one by Lee and Lee (2002), which analyses location determinants of manufacturing establishments which moved locations. Lee and Lee (2002) use a cross-sectional analysis (as opposed to a multi-year panel data analysis) based on discrete choice modelling. Lee and Kim (2005) investigate location determinants of new manufacturing establishments in cities, also using a cross-sectional analysis with a discrete choice modelling framework.

7. Theoretical models of economic geography suggest the development of large-scale transport infrastructure significantly affects the spatial distribution of economic activities (Krugman, 1991; Fujita et al., 2001). The expansion of transport infrastructure is important because it reduces transport expenses required to reach market and thereby can affect the spatial distribution of economic activity. For instance, in the case of a rise in transportation costs, economic activity tends to disperse, whereas in the case of a decrease in transportation expenses and an increase in the regional accessibility, establishments tend to pursue economic benefits through agglomeration. These important and sometimes conflicting effects suggest the importance of sound planning and policy tools that are based on research into these impacts in projects (Short and Kopp, 2005).

8. For this reason, in order to establish effective regional development policies and transportation infrastructure planning, it is necessary to conduct a systematic analysis of how the location of new manufacturing sites have been impacted by investment in transport infrastructure. Until today, despite Korea's considerable fiscal investment in major transport infrastructure such as expressways, there are few studies of economic spillovers, in particular the spatial change in economic activity caused by the construction of expressways.

9. The objective of this study is to analyse the impact of transport infrastructure investment on the spatial distribution of economic activity, in order to establish effective policies for regional development and transportation infrastructure planning. This study analyses the impact of the opening of the West Coast Expressway in Korea, which was completed in December 2001, on the location of new manufacturing establishments by technology level and size.

10. Analysing the West Coast Expressway is useful because it is one of the most recent and largest transport infrastructure investments in Korea. Also, its major construction goals were to stimulate industrial development of nearby regions and to facilitate traffic flow around existing industrial complexes. Furthermore, this study focuses on new manufacturing establishments due to their significant spillover effects on local economies.

11. It is intended that the results can contribute to helping establish effective regional development policies and support transportation infrastructure planning by identifying the impacts of expressway construction on changes in the spatial distribution of economic activity.

2. Data

12. The West Coast Expressway (see Figure 1) - the largest project among newly opened expressways - is now the second longest expressway in Korea. It is also known as the North-South axis of the national trunk road. This study limits the survey scope within the area where the expressway passes through or is located nearby, notably: the Seoul Metropolitan city, Incheon Metropolitan city, Daejeon Metropolitan city, Gwangju Metropolitan city, Gyeonggi province, Southern Chuncheong province, Northern Jeolla province, and Jeolla province. For the purposes of this study a panel dataset has been constructed for the years 1997 through 2006, a 10 year period. The road opened in sections over the time period from July 1994 through December 2001, and observations were only used for sections that were open in the study period. The primary source dataset is the Korea Mining and Manufacturing Survey conducted every year by Statistics Korea.

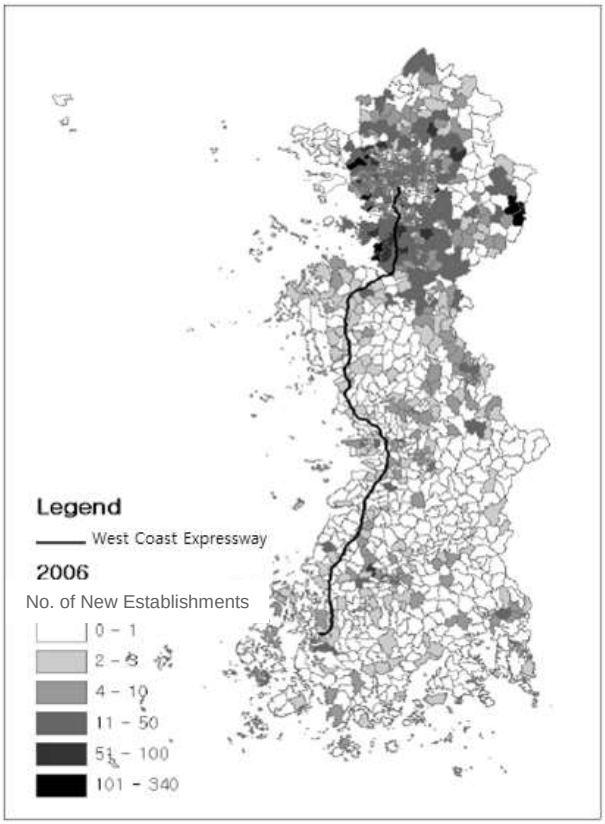
13. The spatial resolution of a location study is of importance. If the spatial unit is too large, it becomes impossible or meaningless to use variables such as the distance to the nearest expressway interchange (IC) to capture local effects. It is of key interest in this study to investigate the effect of accessibility to the previously existing freeway network as well as the accessibility to the new West Coast Expressway on the number of new manufacturing establishments. Kim et al. (2008) show that most

preceding analyses on location which use aggregate spatial units, i.e. not absolute micro-scale such as land parcels, use relatively large units such as a metropolitan area, county, province, or a nation.

14. Unlike previous studies (Lee and Lee, 2002; Lee and Kim, 2005), the present work conducts the analysis using the smallest available administrative units used in Korea. Three non-overlapping units are used to form the spatial unit of the study. Cities are divided into *wards* (Korean: dong), urban areas smaller than cities, i.e. *towns* (Korean: eup) are their own single unit, and rural areas are divided into *districts* (Korean: myeon). These three administrative areas form the basic spatial unit of this study. The average area of the spatial unit is about 20 km^2.

15. During the 10 years under study the definitions of these areas changed. A unified definition was used in this study, corresponding to the situation in 1997. This leads to 2,029 observations (one for each spatial unit) per year, or a total of 20 290 observations in the whole 10 year panel. Figure 1 displays the 2,029 administrative areas used as the spatial unit of observations, indicating the number of new manufacturing establishments in each area in 2006.

Figure 1. Number of New Manufacturing Establishments in 2006



16. The impact of new transport infrastructure on the location of new manufacturing establishments could turn out differently depending on the technology level and size of the establishment. Moreover, depending on type and size, an establishment may react differently to control variables such as the average land price and wages. Therefore, this study first conducts a regression analysis on all new manufacturing establishments. This is followed by separate regression analyses for the number of new manufacturing establishments in sectors with different technology levels defined according to OECD standards, following a method described by Ahn (2006). The number of new manufacturing establishments is classified into three size categories and a model is developed for each size. A workplace with 5–10 workers on average per year is defined small, a workplace with 11–30 workers is defined medium-sized, and a workplace with 31 or more workers is defined large.

17. The dependent variable is the number of new manufacturing industry establishments formed in each spatial unit in each year by technology level and size. The number is found by identifying and counting new business IDs in the Korea Mining and Manufacturing Survey dataset each year. Table 1 lists the dependent variables (number of new manufacturing establishments, overall, by technology level, and by size) and the explanatory variables, along with their source and descriptive statistics.

Table 1. Descriptive Statistics of Variables and Data Sources

		1997		2006	
Variable		Mean	St. Dev.	Mean	St. Dev.
Number of all new manufacturing establishments	M	6.26	22.30	6.12	19.56
Number of new high-tech manufacturing establishments	M	0.45	1.91	0.76	3.88
Number of new medium-high-tech manufacturing establishments	M	1.38	6.79	1.51	6.62
Number of new medium-low-tech manufacturing establishments	M	1.35	6.42	1.33	5.56
Number of new low-tech manufacturing establishments	M	3.06	11.51	2.49	7.28
Number of new small manufacturing establishments	M	4.12	15.30	4.09	12.73
Number of new medium manufacturing establishments	M	1.75	6.58	1.69	6.24
Number of new large manufacturing establishments	M	0.39	2.15	0.34	1.47
The shortest distance from the West Coast Expressway IC	G	81.51	83.76	28.52	24.09
The shortest distance from the existing expressway IC as of 1997	G	14.90	19.68	14.91	19.68
Road ratio (road area / administrative district area)	P	0.06	0.05	0.07	0.05
The distance from the CBD of neighboring large cities	G	32.90	25.90	32.90	25.90
Average wage of employed workers in manufacturing (unit: 1 million KRW)	M	13.24	3.34	21.65	7.75
Average land price (unit: 10 000 KRW)	L	50.43	71.13	83.08	117.48
Population density (1 000 people/km^2)	S	6.78	8.20	6.85	8.08
Number of employees in existing manufacturing (unit: 1 000 people)	M	12.76	15.53	13.71	19.52
Number of employees in existing high-tech (unit: 1 000 people)	M	1.97	4.17	2.74	5.86
Number of employees in existing medium-high tech (unit: 1 000 people)	M	3.51	6.13	3.94	7.54
Number of employees in existing medium-low tech (unit: 1 000 people)	M	2.33	3.83	2.82	5.26
Number of employees in existing low-tech (unit: 1 000 people)	M	4.88	4.98	4.17	4.55
Area of current district (‘eup,’ ‘myeon,’ or ‘dong’) (unit: km^2)	G	20.29	26.90	20.29	26.90
Congestion restriction zone	G	0.44	0.50	0.44	0.50
Growth management zone	G	0.08	0.28	0.08	0.28
Nature conservation zone	G	0.02	0.15	0.02	0.15

Data originates from: (M) Mining and Manufacturing Survey; (G) Geographical Information System calculation; (P) Korea Ministry of Public Administration and Security; (L) Korea Ministry of Land, Transport and Maritime Affairs; (S) Statistics Korea. Expressway interchange is denoted IC.

18. The variables measuring the shortest distance to the nearest West Coast Expressway interchange (IC) and the shortest distance to the nearest interchange of the existing freeway in 1997 are calculated using a Geographic Information System (GIS) as a straight line to the geometric centre of each spatial unit. With these variables the effect of the West Coast Expressway can be estimated while controlling for the impact of the existing freeway on the location choice of new manufacturing establishments.

19. The study includes the road ratio - as an alternative measure of transport infrastructure - which is the road area divided by the area of the spatial unit in order to control for overall transport infrastructure level of each location.

20. The distance from a neighbouring CBD is calculated in a GIS as the distance in a straight line from the nearest large city, such as Seoul, Daejon, and Gwangju, to the geometric centre of each spatial unit location. The distance is included in order to control for the influence of large cities due to their various services (Wu, 1999; Kim et al., 2008).

21. The average wage of workers in manufacturing establishments is the total wage across all manufacturing establishments by region divided by the total number of employed workers. The average wage is expected to bring negative impacts on the location choice by manufacturing establishments, particularly as the technology level of the establishment decreases.

22. This study includes land price in the analysis, drawn from official assessed reference land price values in each area. In a study using a single city, i.e. mono-centric, there would be concern for the endogeneity of land price. However, this study belongs to the Weberian cost-minimization tradition in that it covers multiple regions, cities, and towns. Furthermore, this analysis concerns only one type of business and the spatial unit is small. Land price can therefore be considered exogenous in this study.

23. The analysis includes population density in order to control for the heterogeneity of the areas and also to control for the size of potential labour market or entrepreneur pool. The analysis also includes the area of each spatial unit in square km, to control for the varying spatial extent in the data.

24. The number of employed workers in existing manufacturing establishments is included in order to control for agglomeration economies. The importance of agglomeration economies has been previously emphasized in regional-level studies on establishment location (Guimarães et al., 2000; Arauzo and Manjón, 2004) and metropolitan-level studies (Shukla and Waddell, 1991; Rosenthal and Strange, 2003).

25. Lastly, this study includes three indicator variables to represent growth restriction zones under the 2nd Seoul Metropolitan Area Readjustment Planning - amended in 1994 and effective since 1997 - as a way to control for the effect of these policies on the number of new manufacturing establishments.

3. Methods

26. When estimating the pattern of location choice of establishments pursuing profit maximization, Carlton (1983) and Bartik (1985) adopted the discrete choice model, and since then such frameworks have been adopted by most studies on establishment location. However, this framework brings limitations in context of numerous alternative locations and due to strict assumptions on independence of the alternative locations, which would be difficult to justify in a study such as this one, with 2 029 locations.

27. As another approach, location studies have used count models, such as the Poisson (Papke, 1991; Becker and Henderson, 2000; Holl, 2004a) or negative binomial (Wu, 1999; Coughlin and Segev, 2000; Holl, 2004b). Count models have been shown to be equivalent to a random utility maximization framework (Guimarães et al., 2003). This study therefore uses count models to estimate the location choice of new manufacturing establishments.

28. Since the data is a time-series panel, this study adopts the fixed-effect count model which was developed by Hausman et al. (1984) and first applied in a study on location choice of establishments by Papke (1991) to reduce the potential endogeneity or simultaneity between establishment location and new transport infrastructure by controlling for unobserved location characteristics.

29. As seen in Table 1, the variance (the standard deviation squared) is higher than the mean number of new manufacturing establishments. Such over-dispersed data may be better modelled with a Negative Binomial model rather than Poisson where the variance must equal the mean (Cameron and Trivedi, 2013).[1]

30. Compared to a cross-section analysis, a panel analysis has the following main benefits. First, the cross-sectional analysis produces a bias in the parameter estimates when unobserved location characteristics are correlated with included location characteristics. The fixed-effect model can effectively reduce the possibility of omitted variable bias in the parameter estimation because it can control for the effects of unobserved location characteristics within the spatial units. Second, the fixed-effect model can reduce the potential endogeneity between the number of new manufacturing establishments and the new transport infrastructure by controlling for the relationship between the two. The fixed-effect analysis can therefore produce consistent outcomes even when unobserved location characteristics exist.

31. In the case of a typical linear panel model, a time invariant variable cannot be used as a linear variable in a fixed-effect regression analysis. However, in the panel regression analysis using the Negative Binomial model with a conditional likelihood as presented in (2) the region-specific heterogeneity term is not in the likelihood, which means that time invariant explanatory variables can be used in this fixed-effect regression analysis (Hausman et al. 1984). This study therefore can use potentially important variables such as the distance to the existing expressway IC as of 1997, the distance to the CBD of neighbouring large cities, the area of the observations' administrative districts, and growth restriction zones of the Seoul Metropolitan Area.

32. Time invariant dependent variables still cannot be used. This means that any region where the number of new manufacturing establishments does not change throughout the 10 years of the study period will be dropped from the analysis. In this dataset this only occurs for regions where there were no new establishments.

[1] The negative binomial model is based on representing the natural logarithm of the expected number of new manufacturing establishments, λ_{it}, in location i at time t with the following parameterization:

$$\ln \lambda_{it} = \beta x_{it} + \epsilon_{it}, \quad (1)$$

where β is a vector of estimable coefficients on the explanatory variables x_{it}. The exponentiated unobserved error term ϵ_{it} is assumed to be gamma distributed with mean one and variance α. The joint conditional negative binomial probability of n_{it} new manufacturing industry establishments in location i at time t for all time periods T_i observed for location i is then:

$$P\left(N_{i1} = n_{i1}, \dots, N_{iT_i} = n_{iT_i} \middle| \beta, \sum_{t=1}^{T_i} N_{it} = \sum_{t=1}^{T_i} n_{it}\right) = \frac{\Gamma\left(\sum_{t=1}^{T_i} e^{\beta x_{it}}\right)\Gamma\left(1+\sum_{t=1}^{T_i} n_{it}\right)}{\Gamma\left(\sum_{t=1}^{T_i} e^{\beta x_{it}}+\sum_{t=1}^{T_i} n_{it}\right)} \prod_{t=1}^{T_i} \frac{\Gamma\left(e^{\beta x_{it}}+n_{it}\right)}{\Gamma\left(e^{\beta x_{it}}\right)\Gamma(n_{it}+1)}. \quad (2)$$

The coefficients, β, are estimated with the method of maximum likelihood using the software Stata (StataCorp, 2013a, 2013b).

4. Results

33. The estimation results are presented first for the model of the total number of all new manufacturing establishments in each spatial unit, then the four models for the technology levels, and three models by establishment size. The Hausman test (Hausman, 1978) reveals that the fixed-effect structure performs statistically better than random-effects in all the models.

4.1. Location Determinants of New Manufacturing Establishments

34. The location determinants of all new manufacturing establishments are analyzed first. The results are in Table 2. There were 184 regions with no new manufacturing establishments in the 10 year period, resulting in a total of 1,840 observations being omitted from the panel analysis due to a requirement for a time varying dependent variable as discussed in the methods.

35. The results show the West Coast Expressway is found to have a statistically significant impact on the location choice of new manufacturing establishments. When the distance from a West Coast Expressway IC increases by 1 km, the expected number of new manufacturing establishments decreases by 0.26%. This indicates that the investment in new transport infrastructure changes the new manufacturing establishment's preference for location and consequently causes a significant impact on the spatial distribution of economic activity. Such an explanation is possible because this analysis effectively controls for the potential endogeneity and simultaneity between the location of new manufacturing establishments and the new investment in transport infrastructure by using the fixed-effect panel negative binomial model.

36. The distance from the existing expressway IC as of 1997 is found to be statistically significant and produces negative effects. This shows that despite the opening of the West Coast Expressway, the accessibility to the existing expressway still acts as an important location determinant for new manufacturing establishments. The road ratio shows a positive tendency on the location of new manufacturing establishments, but the effect is not statistically significant.

37. The distance from the CBD of neighbouring large cities is statistically significant and produces a positive effect. This means that when other conditions stay the same, new manufacturing establishments prefer to locate nearby large cities, such as Seoul, Daejon, and Gwangju.

38. The average wage of workers in the manufacturing industry also turns out statistically significant and causes a negative impact on the number of new manufacturing establishments. When the annual average wage increases by 1 million KRW, the expected number of new manufacturing establishments decreases by 1.34%.

39. The land price is significant and linked to a negative impact on the number of new manufacturing establishments which fits previous studies. When other conditions are the same, the expected number of new manufacturing establishments would decrease by 0.24% as the land price rises by 10,000 KRW per square meter. This result can be interpreted to mean that policy makers need to be cautious with respect to the price of land when attempting to attract new manufacturing industry establishments.

Table 2. Negative binomial model of the number of new manufacturing industry establishments

Variables	Coefficient (Standard Error)
Constant	1.7729 (0.1029)***
The shortest distance from the West Coast Expressway IC	-0.0026 (0.0003)***
The shortest distance from the existing expressway IC as of 1997	-0.0092 (0.0021)***
Road ratio (road area / administrative district area)	0.2598 (0.8243)
The distance from the CBD of neighboring large cities	-0.0047 (0.0018)***
Average wage of employed workers in manufacturing industry (unit: 1 million KRW)	-0.0134 (0.0020)***
Average land price (unit: 10 000 KRW)	-0.0024 (0.0002)***
Population density (1 000 people/km^2)	0.0205 (0.0050)***
Number of employees in existing manufacturing (unit: 1 000 people)	0.0166 (0.0011)***
Area of current district ('eup,' 'myeon,' or 'dong') (unit: km^2)	0.0004 (0.0016)
Congestion restriction zone	-0.6461 (0.0906)***
Growth management zone	-0.4491 (0.1035)***
Nature conservation zone	-0.2306 (0.1970)
Observations	18 450
Log-likelihood at zero	-34 503.76
Log-likelihood at convergence	-31 389.73

* Denotes a p-value of 0.1 or smaller; ** denotes a p-value of 0.05 or smaller; *** denotes a p-value of 0.01 or smaller. Standard errors are in parentheses.

40. The population density is statistically significant and produces a positive effect. This indicates that when other conditions stay the same, new manufacturing establishments prefer a location with a sufficient labour force. The number of existing employed workers, which this study uses as a measure of agglomeration economies, is statistically significant and produces a positive effect. When the number of employed workers rises by 1 000, the expected number of new manufacturing establishments increases by 1.66%.

41. Although most of the variables are statistically significant, the area in square km of the current location district (whether it is a 'eup,' 'myeon' or 'dong') is not significant. This variable is included in the analysis to control for the size of the location spatial unit. However, lack of variance in this variable renders it not significant.

42. Among the three variables included to control for the effects of the Seoul Metropolitan area location policy zones, the congestion restriction zone and the growth management zone turn out statistically significant. Both produce a negative effect on the entry of new manufacturing establishments. This means that when other conditions stay the same, fewer new manufacturing establishments enter the congestion restriction zone and the growth management zone because of location regulations and the Total Industrial Site Volume Control System (ISVCS). The effect of the congestion restricted zone is the greatest, almost 44% greater than the effect of the growth management zone. These results show the location policy is linked to constraints on growth. The natural conservation zone is not statistically significant, although the direction shows a trend towards constraining growth.

4.2. Location Determinants of New Manufacturing Establishments by Technology Level

43. The effects of accessibility to transport infrastructure and other factors on the preferred location of manufacturing establishments could vary with their technology level. This study therefore classifies manufacturing establishments by technology level (high-tech, medium-high-tech, medium-low-tech, low-tech, as discussed in the data section) and develops fixed-effect negative binomial regressions for each. The results are shown in Table 3. The number of observations varies in the models since there are regions with no new manufacturing establishments of the particular technology level during the entire 10 year period and such observations must be omitted as discussed in the methods.

44. Increasing distance from a West Coast Expressway IC leads to statistically significant negative impacts on new manufacturing establishments of all technology levels. However, comparing the size of regression coefficients, the accessibility from the West Coast Expressway IC generally turns out to exert a relatively stronger impact on the location of new high-tech manufacturing establishments.

45. The access to the existing expressway as of 1997 is found to have a statistically significant impact on the location of low-tech manufacturing establishments alone. The regression coefficient is larger than the coefficient on access to the West Coast Expressway. This suggests new low-tech manufacturing establishments appear to prefer the accessibility to the existing expressway over the West Coast Expressway, which matches the descriptive statistics shown in Table 1.

46. The road ratio is found to have a statistically significant positive effect on high-tech and medium high-tech establishments. Considering that the location choice of manufacturing establishments with these two technology levels is not statistically significantly affected by accessibility to the existing expressway, the interpretation is that high- and medium-high tech manufacturing establishments tend to put more focus on the overall transport infrastructure level than on accessibility to the existing expressway.

47. The average wage of workers in manufacturing establishments indicates statistically significant negative coefficients for the three lower technology levels, i.e. excluding high-tech. In addition, the regression coefficients increase as they move from high-tech to low-tech, which suggests that new manufacturing establishments in the low-tech sector appear to be more responsive to the average wage of workers at local manufacturing establishments.

48. Regardless of technology level, all manufacturing establishments are responsive to average land prices when they decide on new location. The regression coefficients on the land price have a statistically significant negative sign for all technology levels. The results suggest the provision of low price industrial sites could serve as incentive to attract high-tech industry as well as low-tech manufacturing establishments. When the land price per square meter rises by 10,000 KRW, the expected number of new high-tech manufacturing establishment decreases by 0.39%.

49. Population density has a statistically significant positive effect on the location decision of new low-tech manufacturing establishments. This is probably because the low-tech sector falls within the labour-intensive industry and therefore has a preference for sufficient labour force in nearby locations. Meanwhile, a higher population density has a negative impact on the manufacturing industry in high-tech and medium high-tech sectors. This is possibly due to the employed workers in these sectors being capable of commuting a relatively longer distance, thanks to their higher income, than those in low-tech sectors.

Table 3. Negative binomial model of the number of new manufacturing industry establishments by technology level

Variables	High-tech Coefficient (Standard Error)	Medium-high Coefficient (Standard Error)	Medium-low Coefficient (Standard Error)	Low-tech Coefficient (Standard Error)
Constant	0.477 (0.3031)	1.667 (0.2337)***	1.233 (0.2066)***	1.647 (0.1452)***
The shortest distance from the West Coast Expressway I	-0.007 (0.0015)***	-0.003 (0.0006)***	-0.001 (0.0004)***	-0.002 (0.0003)***
The shortest distance from the existing expressway IC as of 1997	0.031 (0.0300)	0.001 (0.0078)	0.004 (0.0058)	-0.015 (0.0027)***
Road ratio (road area / administrative district area)	9.434 (1.9710)***	3.956 (1.4811)***	2.279 (1.5579)	-0.546 (1.0148)
The distance from the CBD o neighboring large cities	0.001 (0.0067)	-0.006 (0.0036)**	-0.004 (0.0033)	0.000 (0.0026)
Average wage of employed workers in manufacturing industry (unit: 1 million KRW)	-0.003 (0.0047)	-0.011 (0.0035)***	-0.011 (0.0034)***	-0.016 (0.0026)***
Average land price (unit: 10 000 KRW)	-0.003 (0.0005)***	-0.004 (0.0005)***	-0.005 (0.0005)***	-0.003 (0.0003)***
Population density (1 000 people/km^2)	-0.026 (0.0137)**	-0.025 (0.0104)**	0.013 (0.0107)	0.020 (0.0062)***
Number of employees in existing high-tech (unit: 1 000 people)	0.044 (0.0069)***	0.042 (0.0051)***	0.018 (0.0055)***	0.021 (0.0052)***
Number of employees in existing medium-high tech (unit: 1 000 people)	0.027 (0.0100)***	0.029 (0.0072)***	-0.009 (0.0073)	0.000 (0.0069
Number of employees in existing medium-low tech (unit: 1 000 people)	-0.031 (0.0117)***	-0.021 (0.0083)***	0.040 (0.0084)***	-0.005 (0.0083)
Number of employees in existing low-tech (unit: 1 000 people)	0.024 (0.0077)***	0.044 (0.0065)***	0.054 (0.0067)***	0.067 (0.0045)***
Area of current district ('eup,' 'myeon,' or 'dong') (unit: km^2)	-0.000 (0.0076)	-0.006 (0.0035)**	0.001 (0.0032)	-0.001 (0.0022)
Congestion restriction zone	-0.148 (0.2488)	-0.487 (0.1836)***	-0.518 (0.1676)***	-0.494 (0.1275)***
Growth management zone	-0.151 (0.3397)	-0.454 (0.1867)**	-0.454 (0.1714)***	-0.330 (0.1382)**
Nature conservation zone	0.744 (1.7583)	-0.016 (0.4384)	-0.570 (0.3067)**	-0.202 (0.2662)
Observations	10 624	12 623	13 702	17 960
Log-likelihood at zero	-8 667.76	-14 103.27	-15 676.15	-27 934.16
Log-likelihood at convergence	-8 543.50	-12 102.38	-12 388.01	-23 955.94

* denotes a p-value of 0.1 or smaller, ** denotes a p-value of 0.05 or smaller, *** denotes a p-value of 0.01 or smaller. Standard errors are in parentheses.

50. The number of employees in existing manufacturing establishments is available by technology level. These variables produce mostly statistically significant results, notably for the direct agglomeration of same technology level, which means that technology clustering is of importance to the location of new manufacturing establishments.

51. The location constraint policies of the Seoul Metropolitan area do not bring significant impacts on high-tech manufacturing establishments, whereas they are linked to negative impacts on manufacturing establishments in lower technology sectors. This result is influenced by reduced regulations - or concessions - to attract large high-tech establishments.

4.3. Location Determinants of New Manufacturing Establishments by Size

52. The effects of accessibility to transport infrastructure and other factors on the preferred location of manufacturing establishments could also vary with establishment size. This study therefore also classifies manufacturing establishments by size and develops fixed-effect negative binomial regressions for each size (defined in data section). The results are shown in Table 4. The number of observations varies in the models since there are regions with no new manufacturing establishments of the particular size during the entire 10 year period and such observations must be omitted as discussed in the methods.

53. The distance from the ICs of the West Coast Expressway has a statistically significant negative effect for all establishment sizes. As the distance from a West Coast Expressway IC increases by 1 km, the expected number of new manufacturing establishments decreases by 0.15–0.35%. The regression coefficients of shortest distance to the existing expressway in 1997 display a statistically significant negative sign only for small- and large-sized establishments.

54. The distance from the CBD of neighbouring large cities is statistically significant for the location decision of small- and medium-sized new manufacturing establishments which are found to prefer a location closer to large cities compared to large establishments. This is because large establishments probably have more choices for location than medium- and small-sized manufacturing establishments as well as being more capable of procuring some services on their own rather than relying on the services in large cities.

55. The average wage has a statistically significantly effect on the location of manufacturing establishments regardless of the establishment size. However, a closer look reveals a somewhat unexpected result, which is that small-sized manufacturing establishments act less responsively to the average wage level. It is possible that this is because they are not able to review enough location alternatives and therefore tend to choose a location close to the residence of the establishment's founder.

56. Land price had a considerable impact on the location choice of all manufacturing establishments regardless of their technology level, and the same applies to size. The land price is a critical factor for a new location decision of a manufacturing establishment. When the land price per square meter increases by KRW 10 000, the expected number of new manufacturing establishments decreases by 0.23–0.27% dependent on size.

Table 4. Negative binomial model of the number of new manufacturing industry establishments by establishment size

Variables	Small-size Coefficient (Standard Error)	Medium-size Coefficient (Standard Error)	Large-size Coefficient (Standard Error)
Constant	1.4935 (0.1115)***	2.2037 (0.2217)***	2.7540 (0.5496)***
The shortest distance from the West Coast Expressway IC	-0.0035 (0.0003)***	-0.0015 (0.0004)***	-0.0019 (0.0007)**
The shortest distance from the existing expressway IC as of 1997	-0.0072 (0.0023)***	0.0007 (0.0055)	-0.0238 (0.0083)***
Road ratio (road area / administrative district area)	0.1349 (0.8992)	1.1627 (1.2883)	-3.4053 (2.5442)
The distance from the CBD of neighboring large cities	-0.0058 (0.0020)***	-0.0092 (0.0034)***	-0.0053 (0.0077)
Average wage of employed workers in manufacturing industry (unit: 1 million KRW)	-0.0079 (0.0022)***	-0.0286 (0.0028)***	-0.0200 (0.0049)***
Average land price (unit: 10 000 KRW)	-0.0023 (0.0002)***	-0.0027 (0.0003)***	-0.0025 (0.0006)***
Population density (1 000 people/km^2)	0.0209 (0.0055)***	0.0186 (0.0091)**	0.0497 (0.0255)*
Number of employees in existing manufacturing (unit: 1 000 people)	0.0151 (0.0012)***	0.0203 (0.0014)***	0.0166 (0.0024)***
Area of current district ('eup,' 'myeon,' or 'dong') (unit: km^2)	-0.0007 (0.0018)	-0.0043 (0.0031)	-0.0100 (0.0052)*
Congestion restriction zone	-0.5349 (0.0979)***	-0.7400 (0.1838)***	-1.1286 (0.4729)**
Growth management zone	-0.2130 (0.1132)*	-0.5633 (0.1680)***	-0.8689 (0.3681)**
Nature conservation zone	-0.1143 (0.2164)	-0.1161 (0.3348)	1.2545 (3.5958)
Observations	18 150	15 851	9 713
Log-likelihood at zero	-29 163.20	-17 698.85	-6 345.16
Log-likelihood at convergence	-27 101.85	-16 891.06	-6 039.29

* Denotes a p-value of 0.1 or smaller; ** denotes a p-value of 0.05 or smaller; *** denotes a p-value of 0.01 or smaller. Standard errors are in parentheses.

57. The variable reflecting the Seoul Metropolitan Location Policy has varying impacts depending on firm size, but for all size classes the zones reduce the number of establishments. Large establishments tend to be most affected by the congestion restriction zone and the growth management zone, and to a lesser degree so do medium establishments. The smallest effect is on small businesses. This implies the regulation policies in the Seoul Metropolitan area have measurable effects to restrain growth.

5. Conclusions

58. This study intends to contribute to establishing effective regional development policies and transportation infrastructure planning by analysing the impact of investment in transport infrastructure on the spatial distribution of new manufacturing establishments. This study analysed the impact of the West Coast Expressway in Korea, which was completed in late 2001, on the number manufacturing establishments near the expressway using a 10 year data panel from 1997 through 2006. The analysis was undertaken with a fixed-effect negative binomial model based on geographically disaggregate data units.

59. The increased accessibility arising from the opening of the West Coast Expressway turns out to have a significant impact on the location decision of new manufacturing establishments regardless of technology level or size. Most new manufacturing establishments tend to choose a location near an interchange (IC) of the West Coast Expressway. As the distance from an IC increases by 1 km, the expected number of new manufacturing establishments decreases by 0.19–0.74% according to technology level and 0.15–0.35% according to establishment size.

60. The accessibility to the prior existing expressway as of 1997 is found to have a statistically significant impact on the location of new manufacturing establishments. The overall results imply that when a manufacturing establishment decides on location, accessibility to the existing expressway is as important as the accessibility to the new West Coast Expressway.

61. The average wage of employed workers in local manufacturing establishments is also important. The analysis shows that manufacturing establishments with lower technology level tend to be more responsive to the average wage when deciding on location. The average wage does not have a statistically significant impact on high-tech manufacturing establishments, whereas the number of new medium-high, medium-low, and low technology manufacturing establishments decreases by 1.10%, 1.11%, and 1.66%, respectively, for every 1 million KRW increase in the annual local average wage.

62. Land price is found to produce a negative effect regardless of technology level or size. When the land price per square meter rises by 10 000 KRW, the expected number of new manufacturing establishments decreases by 0.33–0.55% based on technology level and 0.23–0.27% based on size. The largest effect is on medium-high and medium-low technology level establishments and medium-sized establishments.

63. The number of employed workers in existing manufacturing establishments in the local area, a variable to control for the effect of agglomeration economies, is significant. This is consistent with preceding studies. Clustering by technology level is an important location determinant for a new manufacturing establishment.

64. The opening of the West Coast Expressway attracts new manufacturing establishments and contributes to the regional development and industrial progress of the west coast area of Korea. This area was underdeveloped and lagged behind the Gyeongbu axis's (Seoul-Busan) existing economic clusters. The results suggest this investment in expressways serves as an effective tool for regional economic development. This effect is stronger with agglomeration of existing industries and inter-sectoral clustering. Accordingly, if the goal of a new expressway is to promote regional development through industrial development, policy makers need to plan the route and ICs of a new expressway with agglomeration in mind. It is necessary to link to existing economic clusters and take planned industrial locations into account.

REFERENCES

Ahn, S., 2006. "Production Globalization and the Changes in the Industrial Structure and Productivity," Research Monograph 2006-05, Korea Development Institute.

Arauzo, J. M., Manjón, M. C., 2004. "Firm size and Geographical Aggregation: An Empirical Appraisal in Industrial Location," Small Business Economics, 22, 299-312.

Aschauer, D. A., 1989. "Is Public Expenditure Productive?" Journal of Monetary Economics, 23, 177-200.

Bartik, T. J., 1985. "Business Location Decisions in the United-States-Estimates of the Effects of Unionization, Taxes, and Other Characteristics of States," Journal of Business & Economic Statistics, 3(1), 14-22.

Becker, R., Henderson, V., 2000. "Effects of Air Quality Regulations on Polluting Industries," Journal of Political Economy, 108(2), 379-421.

Boarnet, M. G., 1998. "Spillovers and Locational Effects of Public Infrastructure," Journal of Regional Science, 38(3), 381-400.

Bollinger, C. R., Ihlanfeldt, K. R., 1997. "The Impact of Rapid Rail Transit on Economic Development: The Case of Atlanta's MARTA," Journal of Urban Economics, 42, 179-204.

Cameron, A. C., Trivedi, P. K., 2013. "Regression Analysis of Count Data," 2nd ed., Cambridge University Press, New York, US.

Carlton, D. W., 1983. "The Location and Employment Choices of New Firms-An Econometric-Model with Discrete and Continuous Endogenous Variables," Review of Economics and Statistics, 65(3), 440-449.

Conrad, K., Seitz, H., 1994. "The Economic Benefits of Public Infrastructure," Applied Economics, 26, 303-311.

Coughlin, C. C., Segev, E., 2000. "Location Determinants of New Foreign-owned Manufacturing Plants," Journal of Regional Science, 40(2), 323-351.

Fernald, J. G., 1999. "Roads to Prosperity? Assessing the Link between Public Capital and Productivity," American Economic Review, 89, 619-638.

Fujita, M., Krugman, P., Venables, A. J., 2001. "The Spatial Economy: Cities, Regions, and International Trade," The MIT Press, Cambridge, US, 384 p.

Guimarães, P., Figueiredo, O., Woodward, D., 2000. "A Tractable Approach to the Firm Location Decision Problem," Review of Economics and Statistics, 85(1), 201-204.

Hausman, J. A., 1978. "Specification Tests in Econometrics," Econometrica, 46(6), 1251–1271.

Hausman, J. A., B. H. Hall, and Z. Griliches., 1984. “Econometric Models for Count Data with an Application to the Patents-R&D Relationship,” Econometrica, 52, 909-938.

Hernández, A., Jiménez, J. L., 2014. “Does high-speed rail generate spillovers on local budgets? ” Transport Policy, 35, 211–219.

Holl, A., 2004a. “Manufacturing Location and Impacts of Road Transport Infrastructure: Empirical Evidence from Spain,” Regional Science and Urban Economics, 34(3), 341-363.

Holl, A., 2004b. “Transport Infrastructure, Agglomeration Economics, and Firm Birth: Empirical Evidence from Portugal,” Journal of Regional Science, 44(4), 693-712.

Ihlanfeldt, K. R., Raper, M. D., 1990. “The Intrametropolitan Location of New Office Firms,” Land Economics, 66(2), 182-198.

Kim, H., Waddell, P., Shankar, V. N., Ulfarsson, G. F., 2008. “Modelling Micro-Spatial Employment Location Patterns: A Comparison of Count and Choice Approaches,” Geographical Analysis, 40, 123-151.

Krugman, P., 1991. “Increasing Returns and Economic Geography,” Journal of Political Economy, 99(3), 483-499.

Lee, B., Kim, S., 2005. “Analysis of the Impact of Regional Characteristics on Location Decision of New Manufacturing Establishments,” Land Planning, 40(6), 209-227.

Lee, H., Lee, B., 2002. “Analysis of Location Determinants of Manufacturing Establishments Moving within the Seoul Metropolitan Area,” Land Planning, 37(7), 103-116.

Luce, T. F., 1994. “Local-Taxes, Public-Services, and the Intrametropolitan Location of Firms and Households,” Public Finance Quarterly, 22(2), 139-167.

Mejia-Dorantes, L., Lucas, K., 2014. Public transport investment and local regeneration: A comparison of London's Jubilee Line Extension and the Madrid Metrosur, Transport Policy, 35, 241–252.

Melo, P. C., Graham, D. J., Brage-Ardao, R., 2013. “The productivity of transport infrastructure investment: A meta-analysis of empirical evidence,” Regional Science and Urban Economics, 43(5), 695-706.

Papke, L. E., 1991. “Interstate Business Tax Differentials and New Firm Location-Evidence from Panel Data,” Journal of Public Economics, 45(1), 47-68.

Rosenthal, S. S., Strange, W. C., 2003. “Geography, Industrial Organization, and Agglomeration,” Review of Economics and Statistics, 85, 377-393.

Short, J., Kopp, A., 2005. Transport Infrastructure: Investment and Planning. Policy and Research Aspects, Transport Policy, 12(4), 360–367.

Shukla, V., Waddell, P., 1991. “Firm Location and Land-Use in Discrete Urban Space-A Study of the Spatial Structure of Dallas Fort-Worth,” Regional Science and Urban Economics, 21(2), 225-253.

Singletary, L., Henry, M., Brooks, K., London, J., 1995. "The Impact of Highway Investment on New Manufacturing Employment in South Carolina: A small Regional Spatial Analysis," The Review of Regional Studies, 25, 37-55.

Song, L., van Geenhuizen, M., 2014. "Port infrastructure investment and regional economic growth in China: Panel evidence in port regions and provinces, " Transport Policy, 36, 173–183.

StataCorp, 2013a. "Stata: Release 13." Statistical Software, StataCorp LP, College Station, Texas.

StataCorp, 2013b. "STATA Longitudinal-data/panel-data reference manual." Release 13. StataCorp LP, College Station, Texas, 563 p.

Weber, A., 1929. "Alfred Weber's Theory of the Location of Industries," University of Chicago Press, Chicago, US.

Wu, F. L., 1999. "Intrametroppolitan FDI Firm Location in Guangzhou, China-A Poisson and Negative Binomial Analysis," Annals of Regional Science, 33, 535-555.