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Sustainability Evaluation of Urban Development in the Context of Transportation Planning

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Abstract

Many of the cities in developing countries face various environmental problems caused by rapid population growth, high population density, high vehicle ownership, limited investment for environmental protection and lack of institutional capacity for environment management (SCEM). These environmental issues problems in these countries range from include urban environment quality deterioration, natural resource degradation, and the declining quality of coastal and marine resources. This study evaluates sustainability of urban development incorporating the influence of both SCEM and transportation-related factors.

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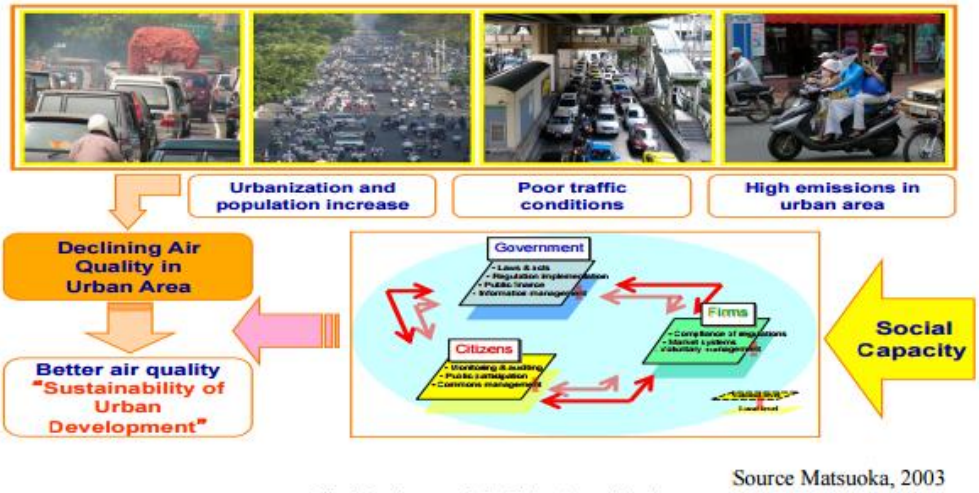
Keywords: sustainability, transportation, urban development

1. Introduction

Many of the cities in developing countries face various environmental problems caused by rapid population growth, high population density, high vehicle ownership, limited investment for environmental protection and lack of institutional capacity for environment management (SCEM). These environmental issues problems in these countries range from include urban environment quality deterioration, natural resource degradation, and the declining quality of coastal and marine resources (Barter et al., 1994). This study evaluates sustainability of urban development incorporating the influence of both SCEM and transportation-related factors. (see Fig.1)



Source Matsuoka, 2003

Fig.1 Background & Objective of Study

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2. Conceptual Model Structure of Evaluation

The concept of sustainability was proposed by United Nations in 1980s to balance economic development and improvement of uman quality of life from the perspective of reducing environmental loads (United Nations, 1987). In those days, discussions focused on how to realize the sustainability from the global viewpoint. Nowadays, global concerns about the sustainability are still high as usual as before. On the otherhand, the importance of sustainability about urban development has been widely recognized by not only environmentalist, but also firms and governmental bodies (Newman, 1999). There exist are various factors influencing the sustainability of urban development, such as land use, travel behavior pattern, energy consumption pattern, and progress of technology, educational level and residents' environmental attitudes. These factors may show varying influences at different stages of urban development. To evaluate the sustainability, it is necessary to develop some comprehensive evaluation tools incorporating the influences of these factors. On the other hand, to seek after the richness, urban areas development is being rapidly promoted in developing countries, which is following different from the development processes experienced in developed countries. However besides, it is difficult to collect the data needed for the evaluation tools. Accordingly, it is urged to develop some simplified evaluation tools considering such data availability both issues have to be properly addressed in the current study. In order to capture the complex cause-effect relationships that existing in the relevant capacity indices, I propose to apply Structure Structural Equations Model (SEM), which is a set of simultaneous equations. Further information of structure equation model will provide in point 3. In this study, I propose using the latent variables to represent the elements of urban sustainability and it first conceptually discusses the possible model structure shown in Fig.2. In the model structure, state dependence refers to the influences of the dependent variables in the past on ones in the present. Heterogeneity is used to represent the different cause-effect relationships between developed and developing cities in the evaluation model system.

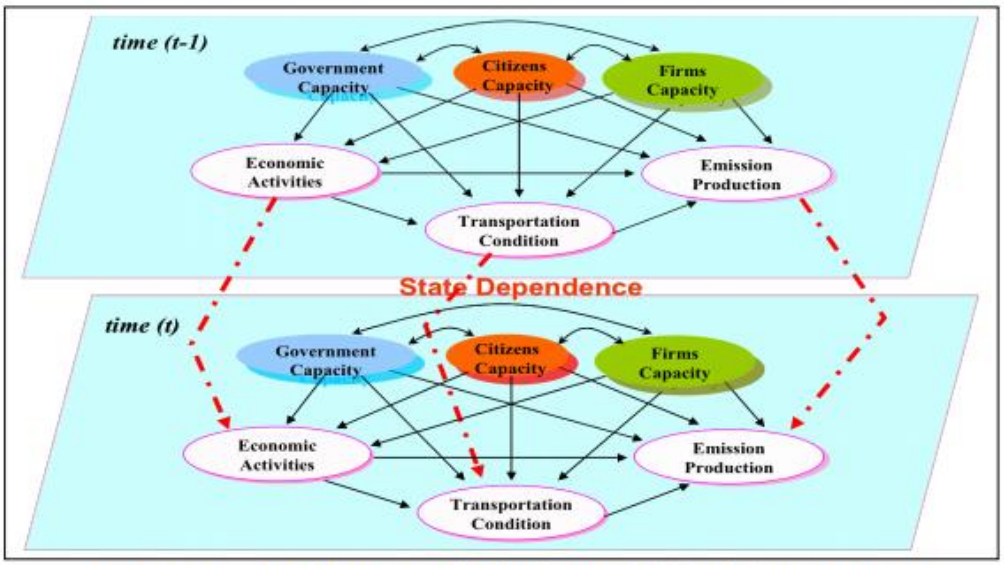

Fig.2 Conceptual Model Structure of Evaluating Sustainability of Urban Development

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3. Structural Equation Model

A structural equation model is used to specify the phenomena under study in terms of putative causeeffect variables and their indicators. Following the descriptions by (Jöreskog and Sörbom, 1989), the full structural model can be summarized by the following three equations:

Structural Equation Model : $\eta = B\eta + \Gamma\xi + \zeta$ (1)

Measurement Model for y : $= \Lambda \eta + \varepsilon$ y y (2)

Measurement Model for x : $x = \Lambda x\xi + \delta$ (3)

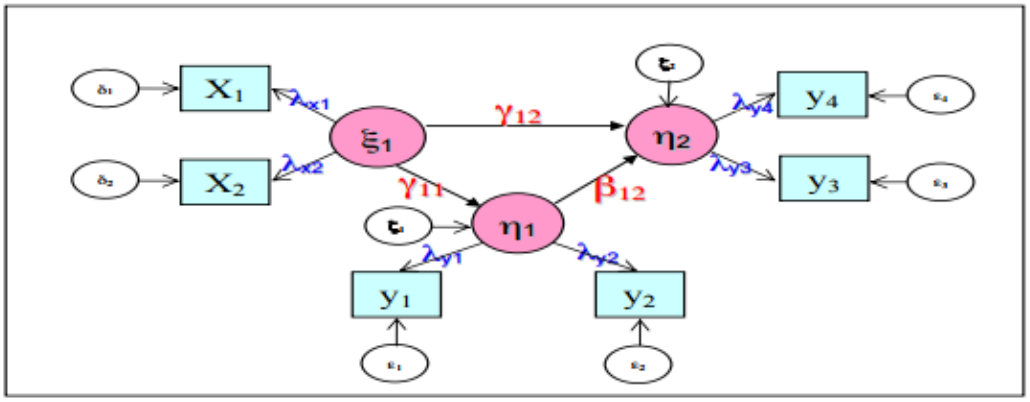


Fig.3 Structural Equation Model

As shown in Fig.3. that: (, ,...,) η = η1 η2 η m ' and (, ,...,) = ξ 1 ξ 2 ξ m ξ' are latent dependent and independent variables, respectively. Vectors η and ξ are not observed, but instead (y , y ,..., y) = 1 2 p y' and (x ,x ,...,x) x' = 1 2 q are observed dependent and independent variables. ζ,ε,δ are the vectors of error terms, and x y B , Γ ,Λ ,Λ are the unknown parameters. In this study, to estimate the parameters of the structural equations, we have used Analysis of Moment Structure (AMOS), which is a Statistical Package for the Social Sciences (SPSS) extension, as it facilitates flexible data organization and interactive estimation procedures. In this research AMOS 5 was used.

4. Data Source

Capacity related data is very limited at the city level, to collect such data in developing cities is also a time-consuming task. On the other hand, there exist some data available at the nation level. Considering such data availability, it becomes necessary to combine these tow type of data in order to derive some operational social capacity indicators. Firstly, using the data collected at the city level to measure the environmental sustainability in the context of urban air quality management. In this study I adopt the “Millennium Cities Database” Vivier, (2001), which compiled by International union of Public Transport (UITP), in collaboration with Professor Jeff Kenworthy and Felix Laube at Murdoch University. The database includes the data covering 100 cities worldwide (see Table. 1). The data collected concerning demographics, economics and urban structure, the car, population, taxis, road network, Parking space, public transport network, (supply use and cost), the mobility of individuals, the choice of transport mode and transport system efficiency and its environment impact (travel time and cost, energy consumption, pollution, accidents, etc.). In total, 66 raw indicators (175 basic raw indicators) have been investigated. Due to the existence of missing data, the following cities were excluded from the analysis in this study: Abidjan, Buenos Aries, Brasilia, Caracas, Casablanca, Delhi Istanbul, Lisbon, Moscow, Salvador, Turin, and Warsaw. As a result 88 cities were selected. On the other hand, since it is difficult to collect capacity-related data at the city level, and it is also expected that capacity at the national level might influence the one at the city level, we further suggest using the capacity-related data at the national level contained in “Environmental Sustainability Index” World Economic Forum,

(2001) to measure the influence of social capacity on environmental sustainability at the city level (see Fig.4).

Table.1 Target Cities Used in the Analysis from International Sourcebook

United State Cities	Australia Cities	Canadian Cities	European Cities	Wealthy Asia Cities	Developing Asia Cities
Houston	Perth	Toronto	Hamburg	Tokyo	Bangkok
Phoenix	Brisbane	Vancouver	Frankfurt	Singapore	Jakarta
Detroit	Melbourne	Calgary	Zurich	Hong Kong	Kuala Lumpur
Denver	Adelaide	Edmonton	Stockholm		Manila
Los Angeles	Sydney	Montreal	Brussels		Surabaya
San Francisco	Canberra	Winnipeg	Paris		Seoul
Boston		Ottawa	London		
Washington			Munich		
Chicago			Copenhagen		
New York			Vienna		
Portland			Amsterdam		
Sacramento					
San Diego					

Source: Kenworthy et al., 2000.

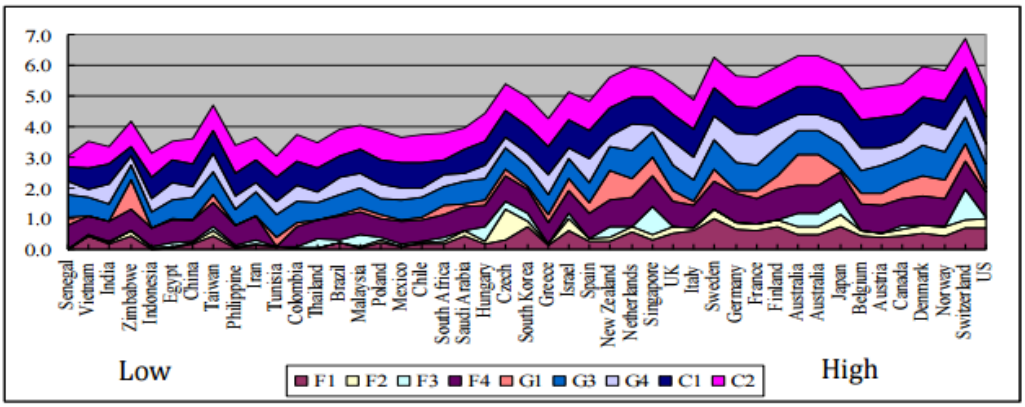
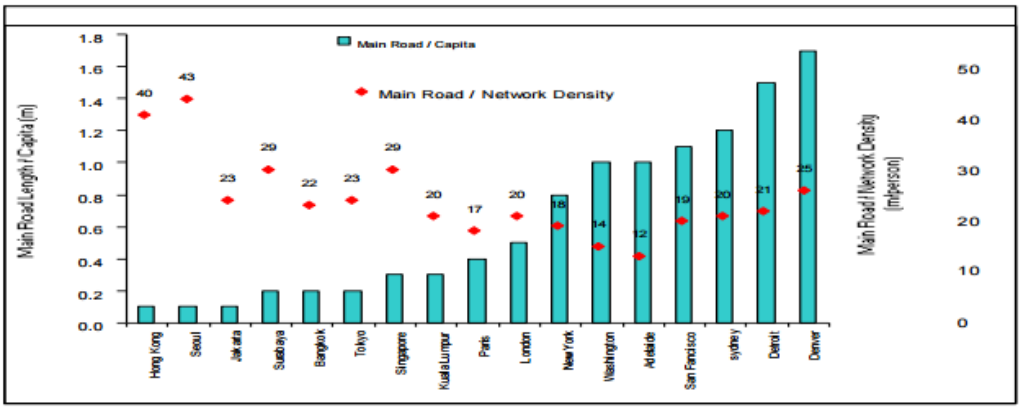


Fig.4 Capacity Indicators for the Target Nations



Source: Barter, 1999.

Fig.5 Main Road Network Density Compared to Main length per Person in Asian Cities & a Number of Other Cities in an International Sample, 1990

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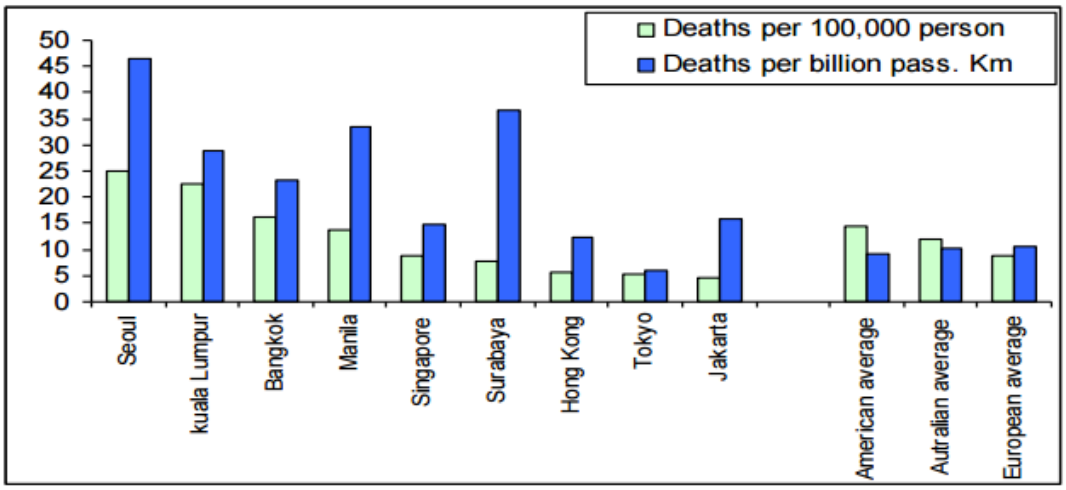

Source: Barter 1999

Fig. 6 Transport Deaths per Capita and per Unit of Mobility in an International Sample of Cities, 1990

5. Estimation Result of Static & Dynamic Models

Model Estimation result showed that each model had a satisfactory goodness-of-fit index. The parameters obtained from static model suggest that the interactions among tree social actors (government, firms and civil society) had significant influences on the reducing of environmental emission. The statistically significant parameter of state dependence suggests validity of the proposal dynamic model.

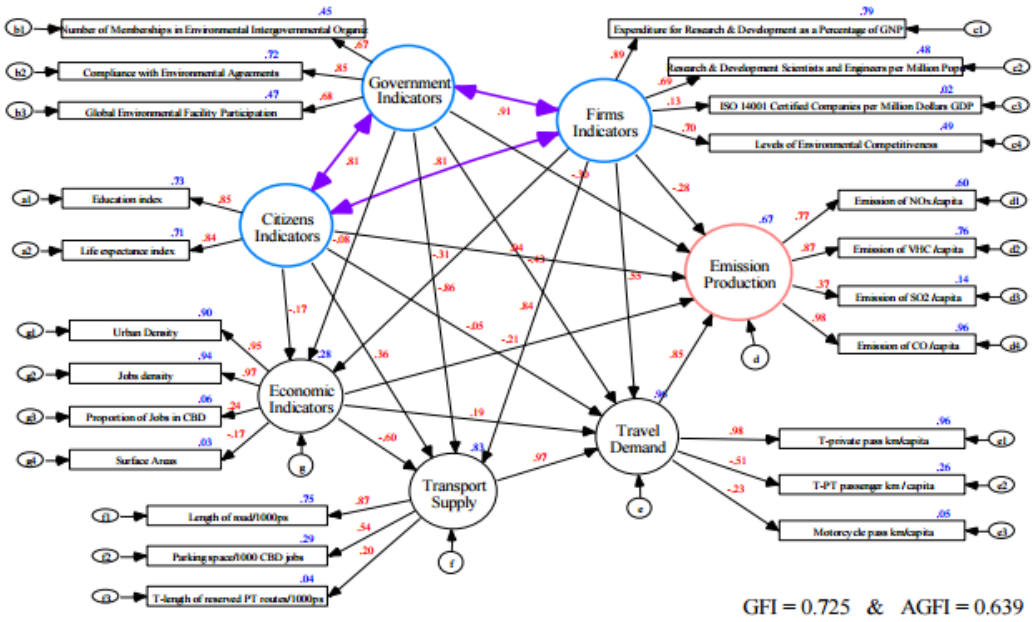

Fig.7 Estimation Result of Static Model

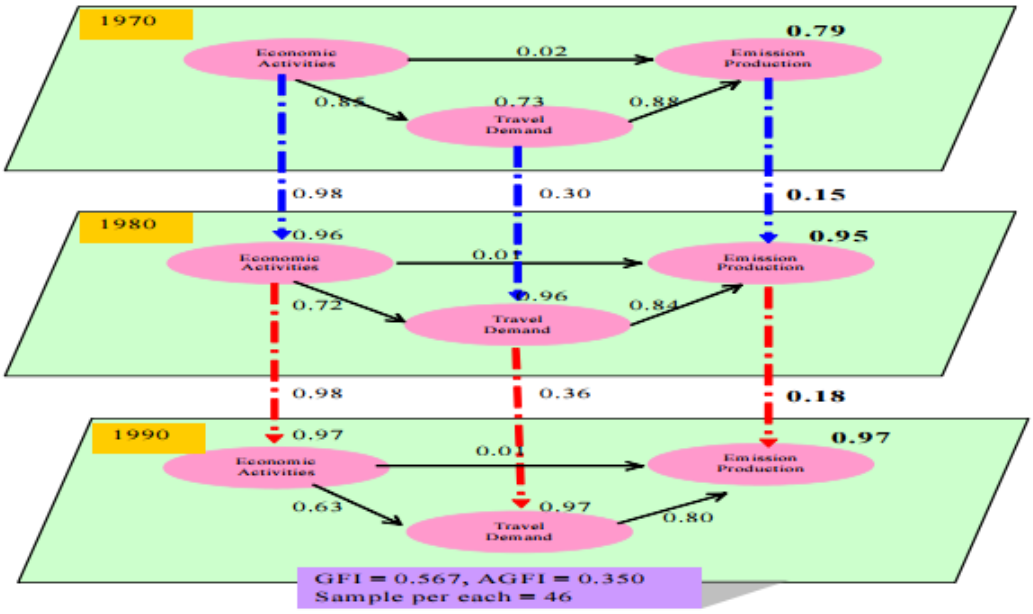

Fig.8 Estimation Result of Dynamic Model

More over it was also a confirmed economic activity become intensive at CDB and inner city area: 1). Parking space, length of road and number of vehicle decrease, implying that that the requirement transportation condition can be relaxed; 2) travel demand and transportation system increase and consequently the one of private transportation system decrease. All these matters suggest that intensive of land use may contribute to the reducing of energy use for transportation system consequently reduce environment emission.

6. Conclusions and Recommendations

It can be concluded that those parameters in static model empirically support assumption that, the relation between or among of three social actors are more significant to reduce environment emission in The analyses. Its means that increasing of social capacity of three important actors makes better cooperation in problem solving related to the transportation policy, consequently can reduce environment emission. And also in the estimation result of dynamic model on the temporal changes in the sustainability of urban development shows the highest emission effected to the year 1990 was “Indirect Effect” krom economic activities in 1970s and 1980s. To reduce emission in next year we should reduce “direct Effect” in this year by applying some policies in transportation sectors. As future research issues, we first need to improve the data collection system, especially Social capacity data and second we need to improve dynamic model structure by properly dealing with the missing data. We also need to develop a continuous urban development stages in different country as well as The influence of other factors (e.g., institution, policies, and planning). Finally, some possibilities policies contribute to the sustainable urban development should be evaluated based on the proposed models.

7. References

[1] Jöreskog, K.G. and Sörbom, D., LISREL7 (1998) A Guide to the program and application, 2nd Edition. SPSS Inc., Chicago

[2] Barter, P. and Kenworthy, J. (1997) Implication of a global review of urban transport and land ude patters: The challenges and opportunities of high density in booming Eastern Asian cities.

ISBN : 978-602-72437-2-9

[3] EEA (2000) Are we moving in the right direction? Indicators on transport and environment in the EU, TERM 2000. Environmental Issues Series, 12, European Environment Agency, Copenhagen.

[4] EEA (2001) Environmental Signals 2001. Environmental Assessment Report 8, European Environment Agency, Copenhagen.

[5] Fujiwara, A., Zhang, J., Okamura, T., and Da Cruz, M. Renato M. (2004b) Using Dynamic Structure Equation Model to Evaluate the Sustainability of Urban Development, Proceedings of International Conference on Civil and Environment Engineering (ICCEE).

[6] Fujiwara, A., Zhang, J., Okamura, T., Lee, B. and Da Cruz, M. Renato M. (2005) Evaluating sustainability of urban development in developing countries incorporating dynamic cause-effect relationships over time, Journal of the Eastern Asia Society for Transportation Studies (forthcoming).

[7] IWG-SDI (2001) Sustainable development in the United States: an experimental set of indicators. Draft Final Report, US. Interagency Working Group on Sustainable Development Indicators, Washington, DC (http://www.sdi.gov/reports.htm).

[8] JICA (1993) Air Quality Management Study for Kelang Valley Region, Final Report, Vol. 2 Main Report. Kuala Lumpur: Japan International Cooperation Agency for Malaysian Ministry of Science and the Environment.

[9] Kenworthy, J., Laube, F.B., Newman, P., Barter, P., Raad, T., Poboon, C., Guia, B. (2000) An international sourcebook of automobile dependence in cities 1960-1990, University of Oklahoma Press

[10] Matsuoka, S. and Kuchiki, A. (2003) Social capacity development for environmental management in Asia, IDE-JETRO in Tokyo

[11] United Nation (1987) Our Common Future. UN World Commission on Environment and Development, Oxford University Press, London.

[12] Vivier, J. (2001) Millennium cities database for sustainable mobility analyses and recommendations, UITP.

[13] World Economic Forum (2001) Environmental Sustainability Index. Global Leaders for Tomorrow Environment Task Force, World Economic Forum and Yale Center for Environmental Law and Policy and Center for International Earth Science Information Network, Davos (http://www.ciesin.columbia.edu/indicators /ESI/ESI 01).

[14] Zhang, J., Fujiwara, A., and Da Cruz, M. Renato M. (2004) Measuring Social Capacity Indicator for Environmental Management of Transportation Sectors in the World Cities, COE conference in China.

[15] Zhang, J., Fufiwara, A., and Da Cruz, M. Renato M. (2005) Measuring Social Capacity Indicators for Environmental Management of Transport Sectors in the World Cities, Journal of the Eastern Asia Society for Transportation Studies (forthcoming).

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