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An Analysis of the Effects of the Compact City on Economic Activities in Japan

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[Abstract]: This paper has been to evaluate how the form and urban policies of “a compact city” affect its economic activities. In order to investigate our research question, we used an urban simulation model constructed by using data on 269 metropolitan areas in Japan in 2000. The major findings in this study are as follows. First, when we increase all transportation conditions by 10%, the “compact city index,” which is measured as the DID population density, increases by 9.2%. Second, when we decrease the car ownership rate by 10%, the compact city index increases by 4.2%. Third, compared with transportation conditions, public facilities and education facilities have only a marginal effect on the compact city index. Forth, the overall increase of total products due to the compactness of a city is small. Fifth, if a policy maker improves the transportation conditions and other compact city measures, total product could be increased by 2.3% (wholesale and retail), 3.4% (financial), 7.3% (real estate) and 1.6% (service). Last, improvement of transportation conditions contributes most to increasing the share of employment.

[Key words]: Compact city; Simulation model of cities; Economic activities; Transportation condition

[JEL classification]: R1, R3, R4, R5

1 Introduction

The main purpose of this paper is to evaluate how the form and urban policies of “a compact city” affect its economic activities. In general, bigger cities have more advantages, such

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as agglomeration economies, but too-big cities have the disadvantages of external diseconomies such as environmental pollution and traffic congestion. Therefore, governments of industrial countries have an interest in promoting compact cities, but empirical evidence regarding how the formation and policies of compact cities affect economic activities is unclear or undocumented. In order to investigate our research question, we will conduct an empirical analysis using data from Japanese cities.

As there is no official definition in Japan, we will first define *metropolitan areas* and create a data set of 269 metropolitan areas in Japan for the year 2000. Then we will estimate cities' urban economic models by using econometric techniques. These urban economic models consist of four sections: 1) a compact city section, 2) a labor section, 3) a production section, and 4) a population section. First, the compact city section shows how the city's compactness measure is determined. Second, the labor section shows how the number of employees, the share of each industry's employees, and such factors are determined. There are 11 industries defined here, including manufacturing, public utilities, retailers, wholesalers, and so on. Third, by estimating the production function in the production section, we will show the extent of each industry's economic activity in a city. The production functions estimated here are for 11 industries. Last, by considering the degree of economic activities, amenities, and so on, we will show in the population section how the city's population is determined.

After we estimate several formulas regarding the above issues, we will conduct simulations in order to evaluate how the degree of a city's compactness affects its economic activities and number of employees. We will also be able to determine what kind of factors affect the degree of a city's compactness.

Finally, after conducting our empirical investigations and considering previous studies as well as the results of our own current study, we will summarize our discussion of optimal city size, in the hope that such empirical results may prove useful in determining policy aimed at achieving a sustainable city size.

2 Pros and Cons of Compact City Policy

2.1 Previous Studies

In this section, we will summarize the pros and cons of the widely debated issue of compact city policy.

Advocates of compact city policy claim that such a policy will improve cities' disorganized sprawl, which has led to the decline of downtown shopping areas. With suburban shopping malls drawing consumers away from central shopping areas, downtown businesses are forced to close down, leading to wasteful land use in city centers. City sprawl also causes

downtown public facilities to suffer from inefficient use and subsequent deterioration. To reorganize the spread-out city shape, certain cities, such as the Japanese cities of Aomori and Toyama, have adopted the compact-city policy of limiting shopping areas and public facilities to central areas. This policy aims to create a sustainable city that achieves a balance between economic activities and a good environment.

Advantages of compact cities could include reductions in energy consumption and external diseconomies from the point of view of transportation policy. For example, disorganized city sprawl causes excessive dependence on auto transportation and wasteful gasoline consumption, leading to environmental burdens such as air pollution. Newman and Kenworthy (1989) show that there is a relationship between gasoline consumption and a city's population density and that a city with a lower population density consumes more gasoline. They therefore propose that city policy should be geared toward higher population density in order to mitigate the dependence on gasoline.

Compact city policy might also contribute to the suppression of crime. In smaller-sized cities, neighbors are arguably more likely to know each other, and this would presumably lead to less perpetration of and greater protection against crime than in a larger city with widespread anonymity.

On the other hand, compact city policy has certain disadvantages. First, the existence of a compact city does not empirically prove its sustainability. In reality, a city grows to acquire agglomeration economies. Zhen (2007) estimates optimal city size by applying econometric analysis to data on Japanese cities and obtains a staggeringly large optimal city size of about 18 million people.

Second, in terms of the quality of the housing environment, a city with a higher population density might be considered by some to be worse than that with a lower population density. Despite advantages in other areas of life, overcrowded housing conditions in the downtown area of compact cities might damage the quality of life.

Third, some argue that crime rate is unrelated to city size. This view is supported by certain empirical studies. For example, according to Bowes and Ihlanfeldt (2001), factors related to crime rate are 1) a high proportion of groups with lower income level, 2) proximity to train stations, and 3) a high proportion of employment in commerce and manufacturing industries. Furthermore, Kutsuzawa et al. (2006) show that 1) the police box station (Koban) system has a controlling effect on crime, 2) areas with a higher proportion of lower income residents have higher crime rates, and 3) areas near trunk roads and areas with densely packed housing have higher crime rates. Thus, studies indicating that crime rate is not related to a city's compactness would indicate that city planning and allocation of facilities are more important factors relative to crime.

Other criticisms of compact city policy planning include the concern that such policy would reduce the freedom of individuals to choose their own lifestyles from among diverse possibilities, such as living in spacious, widely spaced housing in the suburbs.

2.2 Empirical Evidence on Optimal Size of a City

In this section, we will explain the optimal size of a city. As details regarding these results are described in Mizutani et al. (2015), here we will summarize the main points.

Whether compact city policy is correct or not, it is important to know the optimal size of a city. There exist several previous studies empirically investigating the size of a city, for example Yezer and Goldfarb (1978), Capello and Camagni (2000), Nakamura and Kanauchi (2001), and Zheng (2007). First, Yezer and Goldfarb (1978) estimate the relationship between city size and wage in 90 U.S. cities and conclude that there are specific city size ranges where necessary conditions for efficient allocation of resources are not met, particularly cities ranging from 1.5 to 2.5 million in population. Second, Capello and Camagni (2000)'s real purpose is to take a critical view of theoretical work on city size. However, they use 58 Italian cities and show that the city size attaining the highest average location benefit and the lowest average location cost is 361,000 and 55,500 population, respectively. Third, Nakamura and Kanauchi (2001) investigate optimal city size by using Japanese city data for 6 time periods between 1975 and 1997, for 666 and 693 cities for each year. They find that the socially optimal city size in Japan is between 3.32 million and 5.21 million in population. Finally, Zheng (2007) estimates optimal city size by using 43 Japanese metropolitan areas in the year 2000. He estimates both the total benefit and total cost functions based on the models. Zhang concludes that a city of optimal size has a population of about 18 million.

Thus, the previous studies' results show that optimal size is large: more than several million persons. This fact would argue against the compact city policy, if we think of the compact city from the point of view of only physical dimensions. Previous studies fail to consider environmental (i.e. social) costs. In order to overcome the weak points in previous studies, Mizutani et al. (2015) have recently re-examined the issue. By using the same data set as this study, Mizutani et al. (2015) seek to determine optimal city size while simultaneously considering social costs. The results of the study by Mizutani et al. (2015) are summarized as follows.

First, the optimal city size, that attaining the maximum surplus, is between 393,151 and 432,583 persons, much smaller than that found in previous studies. Our study differs from previous work in that social costs are considered, which may account for our much smaller optimal city size. Second, the sustainable limit to city size, in which total benefits equal total costs, is between 1,057,412 and 1,150,207 persons.

Thus, the optimal city size we determine is much smaller than noted in previous studies and in terms of physical size is close to a real-life compact city.

3 Urban Simulation Models

3.1 Structure of Models

There are two main purposes of this study. First, we will investigate what factors most affect the degree of compactness of a city. Second, we will investigate how the degree of compactness affects the industrial structure and employment of a city. To investigate these questions, we build urban simulation models which are reorganized versions of those used in our earlier study, Mizutani et al. (2011). The methodology employs regional econometric models with cross-sectional data. Detailed literature reviews for urban economic models are summarized in Mizutani et al. (2011)¹. In this study, we call our models *urban simulation models* because we are estimating the economic activities and employment situation in a city.

The urban simulation models in this study consist of 4 sub-sections dealing with the following factors: 1) compactness, 2) labor, 3) production, and 4) population. Cause-and-effect relationships among variables in these four sections are shown in Figure 1, where solid-line squares represent endogenous variables and dotted-line squares represent exogenous variables. In this figure, the relationship between social increase and population indicates that the current population is affected by the previous year's social increase.

In this study, we use the population density in DID areas as a proxy variable to show the compactness of a city. When a city is spread out widely, the population density becomes smaller; conversely, when people live more compactly, the population density in DID areas is larger. We therefore define the population density in DID areas as an index of compactness. By investigating these factors, we determine which ones most affect a city's compactness. And by changing the degree of population density in DID areas, we can determine through simulation the effects on industries' products and employment.

¹ There are three groups of empirical urban economic models. The first group consists of regional econometric models with time series data: Fukuchi and Yamane (1976) and Yamane (2003). The second group comprises regional general equilibrium models: Horridge (1999) and Culter and Strelnikova (2004). The third group is the regional econometric model with cross sectional data: Ghali et al. (1981).

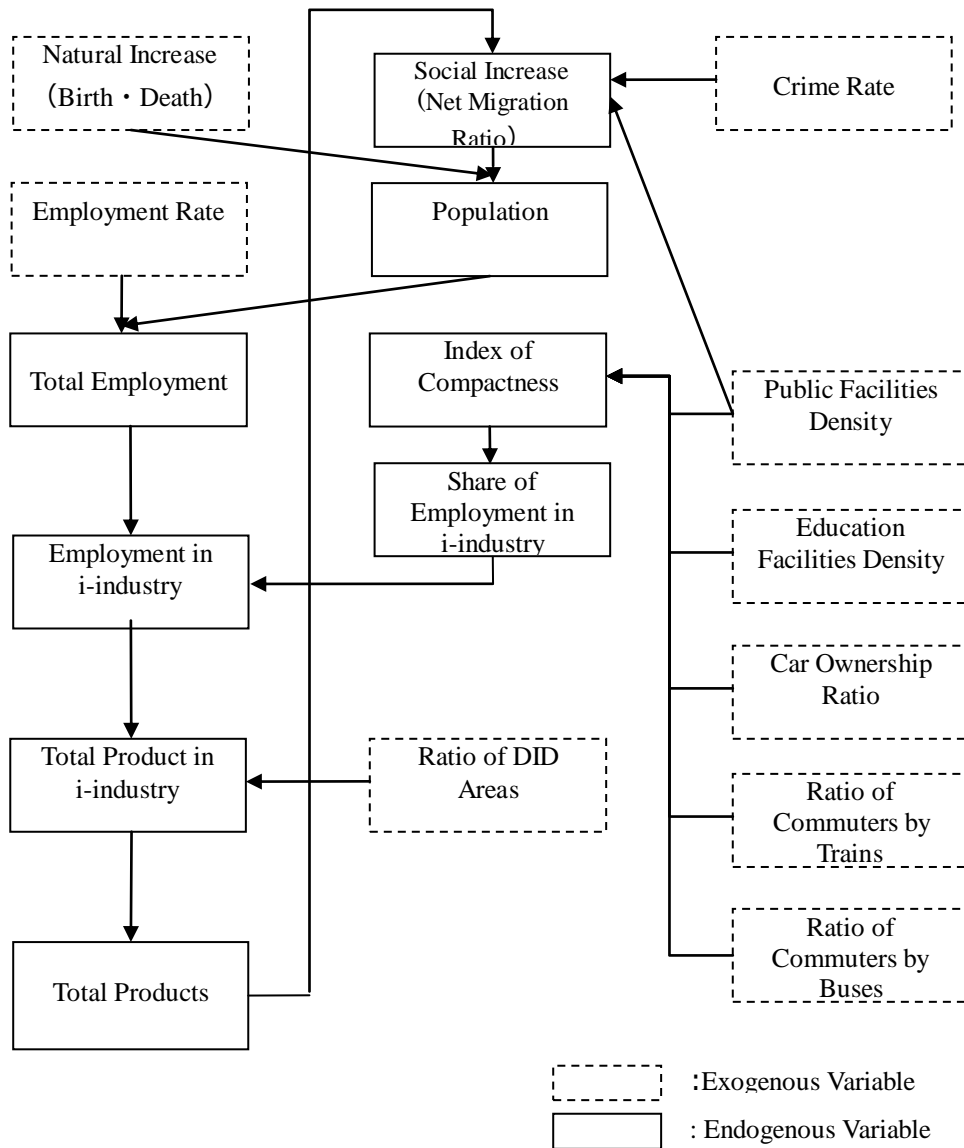


Figure 1 Structure of Urban Simulation Models

3.2 Data

In this study, data are collected based on metropolitan areas. Because there is no definition of *metropolitan area* in Japan, there are no existing data on metropolitan areas. Therefore, we collected data based on the definition of Kanemoto and Tokuoka (2002). For this analysis, total observations are 269, consisting of large and small metropolitan areas in 2000.

The definition of variables for this study is summarized in Table 1.

Table 1 Definition of Variables in the Analysis

Variable	Unit	Definition of Variables
<i>CMPCT</i>	Person / km ²	Index of Compactness DID Population Density = DID Population (person) / DID Area (km ²)
<i>AUTO</i>	Cars / Person	Car Ownership Ratio = Number of Cars / Population
<i>TRCOM</i>	-	Ratio of Commuters by Trains = Number of Non-home Employees and Student Commuters by Train / Number of Non-home Employees and Students
<i>BSCOM</i>	-	Ratio of Commuters by Bus = Number of Non-home Employee and Student Commuters by Bus / Number of Non-home Employees and Students
<i>PHDEN</i>	Facilities / km ²	Number of Community Centers per Area = Number of Community Centers / Area (km ²)
<i>STDEN</i>	Facilities / km ²	Number of Private Preparatory Schools per Area = Number of Private Preparatory Schools / Area (km ²)
<i>SREMP_i</i>	-	Share of Employment in Industry-i = Number of Employees in Industry-i / Total Number of Employees for All industries
<i>VADIN_i</i>	yen	Total products in industry-i (value-added)
<i>DIDAR</i>	-	Ratio of DID Area = DID Area (km ²) / Total Area of Metropolitan Area (km ²)
<i>HSOR</i>	-	Home Ownership Rate = Number of Owned Homes / Total Number of Homes
<i>POP</i>	person	Population
<i>IMRT</i>	-	Net Migration Rate = (Number of Moving-in - Number of Moving-out) / Population
<i>CRMR</i>	-	Crime Rate

3.3 Models in Four Sections

In this section, we will explain the urban simulation models. Among the models, three sub models are by regression. The estimated regression models are (i) determinant equation of compactness (equation – (1)), (ii) determinant equation of share of employment in industry-i (equation-(4)), (iii) determinant equation of total product of industry-i (equation-(6)), (iv) equation of net migration rate (equation – (9)). These four equations are estimated by the OLS.

3.3.1 Compactness

In this study, the compactness of a city is affected by transportation conditions, the

development of education facilities, and the development of public facilities. As for transportation conditions, we consider three variables: the car ownership ratio (*AUTO*), the ratio of commuters by train (*TRCOM*), and the ratio of commuters by bus (*BSCOM*). As for the adequacy of education facilities, we take the number of private preparatory schools per area (*STDEN*) as a proxy variable in this factor. As for the adequacy of public facilities, we take the number of community centers per area (*PHDEN*) as a proxy variable in this factor. These factors affect the compactness of a city. The determinant equation of the index of the compactness of a city is shown in equation-(1)².

[Determinant of Compactness]

$$CMPCT = 8.4294 + -0.3860 \ln (AUTO) + 0.5194 TRCOM + 1.8133 BSCOM + 0.0702 \ln (STDEN) + -0.0016 \ln (PHDEN) \quad (1)$$

where, *CMPCT* : index of compactness (population density in DID),

AUTO : car ownership ratio,

TRCOM : ratio of commuters by train,

BSCOM : ratio of commuters by bus,

STDEN : number of private preparatory schools per area,

PHDEN : number of community centers per area.

3.3.2 Labor

The structure for formulating the degree of employment of each industry in a city is as follows. First, the total employment for all industry in a city (*TLEMP*) is determined by total population (*POP*) and employment rate (*REMP*), as shown in equation-(2). Second, employment of industry-i (*EMP_i*) is determined by total employment (*TLEMP*) and share of employment in industry-i (*SREMP_i*), as shown in equation-(3). The share of employment in industry-i is obtained from equation-(4). As equation-(4) shows, the share of employment in industry-i is determined by the degree of compactness of a city, that is, the index of compactness (*CMPCT*). As the index of compactness is affected by transportation conditions, the adequacy of education facilities and the

² Estimated regression results are as follows: all variables except PHDEN are statistically significant at 1% and adjusted R^2 is 0.3917.

adequacy of public facilities, when we change the degree of index of compactness, we can determine the effects on each industry's employment.

[Determinant of Total Employment Population]

$$TLEMP = POP \cdot REMP , \tag{2}$$

where $TLEMP$: total employment of all industries,
 POP : population in a city,
 $REMP$: employment rate.

[Determinant of Employment of Industry-i]

$$EMP_i = SREMP_i \cdot TLEMP \tag{3}$$

where, EMP_i : employment of industry-i,
 $SREMP_i$: share of employment in industry-i,
 $TLEMP$: total employment of all industries.

[Determinant of Share of Employment in Industry-i]

$$SREMP_i = \beta_0 + \beta_i CMPCT \tag{4}$$

where, $SREMP_i$: share of employment in industry-i,
 $CMPCT$: index of compactness (population density in DID).

$$SREMP_{MN} = 1 - \Sigma(SREMP_i) \tag{5}$$

where, $SREMP_{MN}$: share of employment in mining industry,
 Mining industry is excluded in $\Sigma(SREMP_i)$.

Parameters used for equation- (4) is summarized in Table 2.

Table 2 Parameters Used for Share of Employment in Industry-i

Industry	Parameter		Industry	Parameter	
	β_0	β_i		β_0	β_i

Agriculture	0.7425	-0.0780	Financial	-0.0638	0.0101
Manufacturing	0.3674	-0.0182	Real Estate	-0.0625	0.0081
Construction	0.2688	-0.0188	Transportation & Communications	-0.0636	0.0138
Public Utilities	0.0098	-0.0005	Service Industry	-0.1456	0.0478
Wholesale and Retail	-0.2984	0.0600	Public Sector	0.2283	-0.0225

3.3.3 Production

This section shows a city's economic activities. More precisely speaking, the production function of each industry in a city is obtained here. Total products in industry- i ($VADIN_i$) is measured as value-added and explained by the employment of industry- i (EMP_i) and the ratio of DID area ($DIDAR$), as shown in equation-(6). Furthermore, as the real estate industry is affected by conditions in the housing market, the home ownership rate ($HSOR$) is included in the equation only for the real estate industry.

[Determinant of Total Product of Industry- i]

$$\ln(VADIN_i) = \gamma_0 + \gamma_1 \ln(EMP_i) + \gamma_2 DIDAR + \gamma_3 HSOR \quad (6)$$

where, $VADIN_i$: total products in industry- i (value-added),

EMP_i : employment of industry- i ,

$DIDAR$: ratio of DID area,

$HSOR$: home ownership rate (only for the real-estate industry).

Parameters used for the equation- (6) are summarized in Table 3.

Table 3 Parameters Used for Total Product of Industry- i

Industry	Parameters			
	γ_0	γ_1	γ_2	γ_3

Agriculture	1.2453	0.9421	-36.5550	-
Mining	2.4562	1.0567	-34.7019	-
Manufacturing	2.0413	1.0080	46.7658	-
Construction	2.1158	0.9566	60.8487	-
Public Utilities	4.1555	0.9825	12.3816	-
Wholesale and Retail	0.9504	1.0333	40.3425	-
Financial Industry	2.4714	1.0179	81.4258	-
Real Estate Industry	4.4430	1.0090	-151.3022	0.7321
Transport & Communications	2.1383	1.0008	-35.8142	-
Service	1.8163	1.0079	29.1456	-
Public Service	2.5642	0.9955	3.7300	-

[Definition of Total Products of All Industries]

$$TLVADIN = \sum \exp(\ln(VADIN_i)) \quad (7)$$

where, $TLVADIN$: total products of all industries (value-added),

$VADIN_i$: total products in industry-i (value-added),

3.3.4 Population

This section explains how a city's population is determined. In this study, we focus on social increase and the net migration rate ($IMRT$). The variable of social increase is selected as an endogenous variable. The net immigration rate is affected by the attractiveness of a city. If a city is attractive, then many people relocate there, resulting in a positive net immigration rate. On the other hand, if a city is unattractive and if its people migrate to other cities, the net immigration rate becomes negative. Factors affecting the attractiveness of a city are the degree of economic activity, public safety, crime rate, adequacy of public facilities and so on. In this study, we believe that the net immigration rate ($IMRT$) is explained by total products ($TLPRD$), crime rate ($CRMR$), and the number of community centers per area ($PHDEN$), as shown in equation-(9). Equation-(8) shows the definition of population.

[Definition of Population]

$$POP_{t+1} = POP_t + NIPOP + SIPOP$$

$$= (1 + BTRT - DTRT) \cdot POP_t + (1 + IMRT) \cdot POP_t \quad (8)$$

where, POP_{t+1} : population in the next period (t+1),

POP_t : population in the current period (t),

$NIPOP$: natural increase,

$SIPOP$: social increase,

$BTRT$: birth rate,

$DTRT$: death rate,

$IMRT$: net migration rate.

[Determinant of Net Migration Rate]

$$IMRT = -0.0196 + 0.0014 \ln(TLPRD) - 0.0004 \ln(CRMR) + 0.00002 \ln(PHDEN) \quad (9)$$

where, $IMRT$: net immigration rate,

$TLPRD$: total products,

$CRMR$: crime rate,

$PHDEN$: number of community centers per area.

4 Simulation Analysis

4.1 Scenarios

In this section, using the urban simulation models and taking the Kobe metropolitan area as a case in point, we estimate how the development of a compact city affects the city's economic activities and employment.

For the simulation, we consider the following five scenarios, as Table 4 shows.

Scenario 1 (improvement of only transportation conditions): In this scenario, only transportation conditions improve. The car ownership ratio is decreased by 10%. As the public transportation commuter ratio (i.e. trains and buses) is not increased, this scenario shows a case where most people get around by walking or using bicycles and auto-bicycles.

Scenario 2 (improvement of only transportation conditions): In this scenario, too, only transportation conditions improve. The difference from Scenario 1 is that this scenario includes a 10% increase in the rail commuter ratio in addition to a 10% decrease in the car ownership ratio. This scenario shows an improvement in the city's main transportation mode (i.e. train).

Scenario 3 (improvement of only transportation conditions): In this scenario, not only transportation conditions but also all kinds of public transportation modes are improved. This scenario indicates that the city's main transportation mode (i.e. train) and feeder service mode (i.e. bus) are improved.

Scenario 4 (improvement of both transportation conditions + public facilities): In this scenario, both transportation conditions and public facilities are improved. As for the improvement of public facilities, the number of community centers per area is increased by 10%. However, education facilities remain unchanged.

Scenario 5 (improvement of both transportation conditions + public facilities + education facilities): This scenario adds the improvement of education facilities to Scenario 4. Education facilities are improved with a 10% increase in the number of private preparatory schools per area.

Table 4 Scenarios for the Simulation

Scenario	Improvement of Transportation Conditions			Development of Public Facilities	Development of Education Facilities
	Car Ownership	Train Commuter Ratio	Bus Commuter Ratio	Number of Community Centers per Area	Number of Private Preparatory Schools per Area
Scenario 1	10% decrease	No change	No change	No change	No change
Scenario 2	10% decrease	10% increase	No change	No change	No change
Scenario 3	10% decrease	10% increase	10% increase	No change	No change

Scenario 4	10% decrease	10% increase	10% increase	10% increase	No change
Scenario 5	10% decrease	10% increase	10% increase	10% increase	10% increase
(Note): (1) These scenarios are designed for use in evaluating the case of the Kobe metropolitan area. (2) Values of the current Kobe metropolitan area are 0.3317 for Car Ownership Ratio, 0.4180 for Train Commuter Ratio, 0.1404 for Bus Commuter Ratio, 0.0008 for Number of Community Centers per Area, 0.0118 for Number of Private Preparatory Schools per Area.					

4.2 Simulation Results

In this section, we will evaluate the effects of the compactness of a city. First, we evaluate what kinds of factors affect the measures of a compact city, a summary of which can be seen in Table 5. All factors increase the measure of a compact city, except for public facilities. Among these factors, transportation conditions are the most important, especially the car ownership rate. When we decrease the car ownership rate by 10%, the compact city measure increases by 4.2%. And when we increase all transportation conditions, the measure increases by 9.2%. Compared with transportation conditions, public facilities and education facilities do not increase the compact city measure. Education facilities increase the measure by only 0.7%. These results imply that if a policy maker wants to promote the compact city plan, it would be a good idea to focus first on transportation conditions.

Table 5 Factors Affecting Index of Compact City

Case		Car ownership	Train commuters	Bus commuters	Public facilities	Education facilities
Case 1	Single effect	+ 4.2%	+2.3%	+2.8%	0.0%	+0.7%
Case 2	Case 1 + Car ownership	-	+6.4%	+7.0%	+4.2%	+4.9%
Case 3	Case 2 +Train commuters	-	-	+9.2%	+6.5%	+7.2%
Case 4	Case 3 + Bus commuters	-	-	-	+9.2%	+10.0%
Case 5	Case 4 + Public facilities	-	-	-	-	+10.0%
(Note): (1) The value for the measure of the compactness of a city in Kobe is 8,319 person /km ² . (2) These numbers are compared with the current situation.						

We would like to evaluate the effect on the total products measured as value added. Table 6 shows the results of the effect on the total products when the compact city measures are increased. First of all, when the compact city measures are increased by 10%, the total products of all industries are increased by about 1%. This result shows that as a city promotes compactness, the overall total products increase but not to a large degree. Second, among these compact city measures, the improvement of transportation conditions helps increase the total products of all industries. Compared with transportation conditions, the improvement of public facilities does not have much effect.

As for variation among industries, this table shows clear results indicating what kind of industry increases its total products. Industries such as wholesale and retail, financial, real estate, transportation and communications, and service show a positive effect. However, industries such as agriculture and mining show a large number of negative effects. Industries such as manufacturing and public utilities show mild negative effects. These results suggest that if a policy maker improves transportation conditions and other compact city measures, total product could be increased by 2.3% (wholesale and retail), 3.4% (financial), 7.3% (real estate) and 1.6% (service).

Table 6 Effects on Total Products

Industry	Current total products	Single Effect by				
		Car ownership	Rail commuters	Bus commuters	Public facilities	Education Facilities
Agriculture	64,745	-7.8%	- 4.2%	- 4.9%	0.0%	-1.3%
Mining	8,788	-13.3%	-7.1%	-8.3%	0.0%	-2.1%
Manufacturing	1,926,386	- 0.4%	- 0.2%	- 0.2%	0.0%	- 0.1%
Construction	578,282	- 0.7%	- 0.4%	- 0.5%	0.0%	- 0.1%
Public Utility	311,187	- 0.3%	- 0.2%	- 0.2%	0.0%	- 0.1%
Wholesale & Retail	1,043,478	+ 1.0%	+ 0.6%	+ 0.7%	0.0%	+ 0.2%
Financial	485,153	+ 1.5%	+ 0.8%	+ 0.9%	0.0%	+ 0.3%
Real Estate	933,392	+ 3.2%	+ 1.7%	+ 2.0%	0.0%	+ 0.5%
Transportation & Communications	462,329	+ 0.9%	+ 0.5%	+ 0.6%	0.0%	+ 0.2%
Service	2,066,199	+ 0.7%	+ 0.4%	+ 0.4%	0.0%	+0.1%
Public Service	314,329	- 3.6%	- 1.9%	- 2.2%	0.0%	- 0.6%

Total	8,194,268	+ 0.4%	+ 0.2%	+ 0.3%	0.0%	+ 0.1%
(Note):						
(1) Current total products means the total products value added (million yen) of the Kobe metropolitan area.						
(2) Other numbers represent the degree to which the total products are increased when the compact city measure is increased, compared with the current level of total products.						

In summary, from a comparison among industries or all industries, in any case, it can be seen that the improvement of transportation conditions as a compact city measure is the factor which most contributes to attaining an increase in value added total products of these industries. It is often noted that a decrease in population density in a city's central district causes the hollowing out of the central city, leading to a reduction in value added total products of the city. This phenomenon can be explained by the actual simulation results in the present study.

Next, Table 7 summarizes the effect on the share of employment when compact city measures are increased.

Table 7 Effects on the Share of Employment

Industry	Current share of employment	Single Effect by				
		Car ownership	Rail commuters	Bus commuters	Public facilities	Education Facilities
Agriculture	0.0385	- 8.2%	- 4.4%	- 5.2%	0.0%	- 1.4%
Mining	0.0006	- 12.6%	- 6.8%	- 7.9%	0.0%	- 2.1%
Manufacturing	0.2031	- 0.4%	- 0.2%	- 0.2%	0.0%	- 0.1%
Construction	0.0988	- 0.8%	- 0.4%	- 0.5%	0.0%	- 0.1%
Public Utility	0.0056	- 0.3%	- 0.2%	- 0.2%	0.0%	- 0.1%
Wholesale & Retails	0.2432	+ 1.0%	+ 0.5%	+ 0.6%	0.0%	+ 0.2%
Financial	0.0278	+ 1.5%	+ 0.8%	+ 0.9%	0.0%	+ 0.2%
Real Estate	0.0105	+ 3.1%	+ 1.7%	+ 2.0%	0.0%	+ 0.5%
Transportation & Communications	0.0605	+ 0.9%	+ 0.5%	+ 0.6%	0.0%	+ 0.2%
Service	0.2858	+ 0.7%	+ 0.4%	+ 0.4%	0.0%	+ 0.1%

Public Service	0.0255	- 3.6%	- 1.9%	- 2.2%	0.0%	- 0.6%
(Note): (1) Current share of employment means the share of employment in each industry to total employment in the Kobe metropolitan area. (2) Other numbers indicate the degree to which the share of employment in each industry is increased when the compact city measure is increased, compared with the current level of share of employment.						

First of all, as for the degree of effects, there is much variation among industries. Industries such as wholesale and retail, financial, real estate, transportation and communications, and service show a positive effect. However, industries such as agriculture and mining show a large number of negative effects. Industries such as manufacturing and public utilities show mild negative effects. In a way very similar to the case for total products, these results suggest that if a policy maker improves transportation conditions and other compact city measures, the share of employment could be increased by 2.3% (wholesale and retail), 3.4% (financial), 7.3% (real estate) and 1.6% (service). In contrast to improving transportation conditions, however, improving public facilities has little effect.

In summary, it is clear that the development of transportation conditions is the most important factor in creating positive effects. Improvement of transportation not only contributes to the total product of a city but also improves the share of employment in 2nd industries such as wholesale and retail, financial, real estate, and service. Compared with improving transportation conditions, improving public facilities and education facilities has only a mild effect.

5 Concluding Remarks

The main purpose of this paper has been to evaluate how the form and urban policies of “a compact city” affect its economic activities. In general, bigger cities have more advantages such as agglomeration economies, but too-big cities have the disadvantages of external diseconomies such as environmental pollution and traffic congestion. Therefore, governments of industrial countries have an interest in promoting compact cities, but empirical evidence regarding how the formation and policies of compact cities affect economic activities is unclear or undocumented. In order to investigate our research question, we conducted an empirical analysis using data from Japanese cities. For the analysis, we used an urban simulation model constructed by using data on 269 metropolitan areas in Japan in 2000. For the simulation, we took the Kobe metropolitan areas and evaluated what factors most affected the "compact city index," which is measured as the DID population density. Furthermore, we evaluated to what extent these measures affected the economic activity and employment of a city.

The major findings in this study are as follows.

(1) Almost all factors except public facilities increase the compact city index. Among these factors,

transportation conditions are the most important. When we increase all transportation conditions by 10%, the compact city index increases by 9.2%.

- (2) Among transportation conditions, the car ownership rate is the largest factor. When we decrease the car ownership rate by 10%, the compact city index increases by 4.2%.
- (3) Compared with transportation conditions, public facilities and education facilities have only a marginal effect on the compact city index. Education facilities increase the index by only 0.7%.
- (4) When the compact city index is increased by 10%, the total products of all industries are increased by about 1%. However, the overall increase of total products due to the compactness of a city is small.
- (5) Among these factors, improvement of transportation conditions contributes most to increasing the total products of. However, the improvement of public facilities does not have much of an effect.
- (6) There is much variation on the effect on industries. Industries such as wholesale and retail, financial, real estate, transportation and communications, and service show a positive effect. If a policy maker improves the transportation conditions and other compact city measures, total product could be increased by 2.3% (wholesale and retail), 3.4% (financial), 7.3% (real estate) and 1.6% (service).
- (7) The effects on the share of employment are similar to the case of total product. Improvement of transportation conditions contributes most to increasing the share of employment.
- (8) Compared with transportation conditions, the improvement of public facilities does not have much of an effect on the share of employment.

In addition to these results,

- (9) The optimal city size determined while also considering social costs is about 400 thousand persons, much smaller than in previous studies.
- (10) The sustainable limit to city size, in which total benefits equal total costs, is about 1,100 thousand persons.

In conclusion, an increase of the compactness of a city leads to an increase in the share of employment in industries such as wholesale and retail, financial, real estate and service industries in urban areas. As a result, these industries increase the total products measured as value added. Further, the factor most important to promoting the compactness of a city is the development of transportation conditions. A focus on transportation might be well advised for policy makers interested in fostering compact cities in the future.

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