The Effects of Portland Metropolitan Urban Growth Management on the Commuting Pattern and Jobs-Housing Balance of Different Income Groups

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Abstract

During the past several decades, most of the U.S. metropolitan areas have experienced strong suburbanization of housing and jobs. However, the Portland metropolitan area is well known as a compact city. In general, planning-oriented scholars assert that compact cities can contribute to social equity. On the contrary, market-oriented scholars point out that, compact cities cannot contribute to social equity, because of high housing prices. This paper investigates the impact of Portland metropolitan urban growth management on the jobs-housing balance and commuting pattern of the different income groups, by comparing the relationship between jobs-housing balance and commuting time with other metropolitan areas (Cleveland Metropolitan area and Seattle Metropolitan area). The results indicate that, Portland metropolitan urban growth management had a positive effect on the urban spatial structure of different income levels. In other words, it can be said that Portland metropolitan urban growth management contributed to social equity.

JEL Classification: O18, R14, R41, R52, Z13

Contents

1. INTRODUCTION

During the past several decades, most U.S. metropolitan areas have experienced strong suburbanization of housing and jobs. The literature has shown contrasting views on incentives for moving and jobs-housing balance (hereafter J-H balance). In general, planning approach scholars regard sprawl as the cause of increasing J-H imbalance or spatial mismatch. On the other hand, market-oriented scholars assert that J-H imbalance or spatial mismatch cannot account for actual commuting patterns, because actual commuting includes many factors that are unexplained by spatial mismatch.

In addition, both approaches also have contrasting views on urban sprawl and urban containment (or the compact city). The market-oriented approach emphasizes that urban sprawl is a natural phenomenon, and can reduce urban commuting because people are "rational locaters" (Levinson and Kumar, 1994). On the other hand, the planning approach sees urban sprawl as the cause of urban problems, such as congestion, air pollution, and social segregation. Planning approach scholars emphasize the compact city, because it can reduce congestion and air pollution, and contribute to social equity. However, market-oriented scholars point out the negative effects of urban containment policies. Urban containment policy can cause increases in housing or land price, and reductions in housing affordability (O'Toole, 2007; Richardson and Gordon, 2000). They also argue that urban containment policies contribute to unintended inequities, such as when wealthier households own hobby farms, and are effectively subsidized by lower land values outside the growth boundary (O'Toole, 2003). Growth containment can also threaten open spaces within the boundary areas, because of the lack of available land (Richardson and Gordon, 2000). In addition, urban containment policies tend to restrict the choices of residents, because they discourage the spacious lots that most people prefer to own in suburban areas (O'Toole, 2003). Therefore, they assert that compact cities cannot contribute to social equity.

The Portland metropolitan area is well known as a compact city, mainly due to its Urban Growth Boundary (UGB) and Metro. In addition, the Portland metropolitan area has been discussed as an example for studies on urban sprawl and the compact city. The question then follows: Has the urban growth management of Portland metropolitan area really led to social equity benefit?

Based on two theoretical approaches, this paper analyzes the effects of the urban growth boundary or government interventions on the efficiency of commuting and land use of different income groups in the Portland metropolitan area, in terms of J-H balance. Since an empirical analysis of the relationship of J-H balance and urban commuting helps our understanding of the land-use function for a given spatial structure, a statistical testing of the relationship has been utilized as a viable tool for examining the efficiency of urban land use (Cervero, 1989, 1991; Giuliano, 1991; Peng, 1997; Wang, 2000; Jun, 2004; Ma and Banister, 2006; Park and Kwon, 2009). That is, this functional relationship represents the efficiency of urban land use. In addition, by comparing the relationship between urban commuting time and J-H ratio in other metropolitan areas (Cleveland Metropolitan area and Seattle Metropolitan area*)*, this paper analyzes whether Portland metropolitan urban growth management affects the urban spatial structure of different income groups.

2. LITERATURE REVIEW AND HYPOTHESES

Urban sprawl and the compact city have been contentious issues in urban planning. In general, many scholars have asserted the need for urban containment policy (smart growth or compact city), due to the problems caused by urban sprawl. However, other scholars have asserted the problems of containment policy, such as increases in housing or land price, and reduced housing affordability (O'Toole, 2007; Richardson and Gordon, 2000), and decreases in both the quantity (i.e. size) and quality of new housing stock (Hall, 1997). Urban sprawl is creating negative impact, including habitat fragmentation, loss of aesthetic benefit from the presence of open space, longer commutes, the decay of downtown, reduced social interaction from low density housing, water and air pollution, increasing tax bases and infrastructure costs, inequity, and social stagnation (Ewing, 1997; Porter, 2000; Brueckner, 2000; Squires, 2002; Brody et al., 2006). Therefore, many metropolitan areas have urban growth management policies (e.g. smart growth) to reduce urban sprawl, or to solve the problems that arise from urban sprawl. Then, what are the reasons for suburbanization and urban sprawl? Many urban scholars and experts have discussed these reasons (Bradbury, Downs, and Small, 1982; Mieszkowski and Mills, 1993; Brueckner, 2000).

Bradbury, Downs, and Small (1982) mention the causes of sprawl: 1) rising real income; 2) greater use of cars and trucks; 3) widespread desire of people to live in relatively new and low-density settlements; 4) economic advantages of home ownership (the support of government to purchase housing); and 5) strongly entrenched tendencies for people to segregate themselves socioeconomically and racially by neighborhoods. Mieszkowski and Mills (1993) assert that the causes of sprawl are home mortgage insurance by the federal government, improvement of the interstate highway system, racial tensions, and crime and schooling considerations. Brueckner (2000) asserts three factors of sprawl, which are growing population, rising incomes, and falling commuting costs.

In addition, Brueckner (2000) emphasizes other factors for the causes of sprawl; these factors are three kinds of market failures: 1) failure to account for the social value of open space, 2) failure to account for the social cost of freeway congestion, and 3) failure to fully account for the infrastructure cost of new development. Mieszkowski and Mills (1993) and Lee and Leigh (2005) mention two theories which support suburbanization: natural evolution theory, and flight from blight. Natural evolution theory focuses on transportation and rising income. When a city grows, urban core is firstly developed because of being at the hub of transportation. Therefore, because of commuting costs, employment and residential areas are concentrated in the urban core. However, when land in the urban core becomes filled in, development moves to land in the suburban areas. As new housing is built in suburban areas, high-income groups move there, because they prefer new and larger housing compared to high commuting costs. This phenomenon segregates the housing market. That is, households with low income now live in the central city, and households with high income now live in suburban areas. In addition, this theory supports spatial mismatch and J-H imbalance.

On the other hand, the flight from blight theory emphasizes fiscal and social problems, and relates to Tiebout (1956) theory.[1] Middle and high-income groups would like to move to suburban areas to avoid high taxes, low quality public schools and other government services, racial tension, crime, congestion, and low environmental quality. From both theories, we may therefore conclude that, the main causes of suburbanization and urban sprawl are the rise in

[1] Tiebout's (1956, p. 418) hypothesis states, "The greater the number of communities and the greater the variance among them, the closer the consumer will come to fully recognizing his/her preference position." Therefore, people with rational behavior choose public goods or services as described by "voting by foot," which means consumer-voters move to that community whose local government best satisfies their set of preferences.

incomes, government support for housing, improvement of transportation system, market failure, and the pursuit of good amenities.

To restrain urban sprawl, many governments use urban containment policies. In general, the purposes of urban containment policies are to constrain urban sprawl, and to accomplish a more efficient utilization of land in metropolitan areas (Pendall et al., 2002). Therefore, there have been many discussions about the effect of urban containment policies on urban spatial structure (Nelson and Duncan, 1995; Hall, 1997; Pendall et al., 2002; Dawkins and Nelson, 2002; Anthony, 2004; Jun, 2004; Rodriguez et al., 2006; Wassmer, 2006; Park and Kwon, 2009). The Urban Growth Boundary is one example of urban containment policies (which also include Urban Service area, Greenbelt and so on).

Then, what are urban containment policies? Urban containment policies are similar to urban growth management, which includes UGB, infrastructure policies and other policies related to urban growth that serve to control or manage its impact (Kelly, 1993). In addition, Nelson and Duncan (1995) mention that urban containment policies include government regulation, as well as public ownership of land, and policies regarding the time and sequencing of public infrastructure construction. Based on Nelson and Duncan (1995), Pendall et al. (2002) classify urban containment policies into two kinds: 1) urban growth boundaries and related strategies, and 2) infrastructure policies. According to Pendall et al. (2002), urban containment policies can be divided into two factors: 1) "push" factor, and 2) "pull" factor. They explain the two factors as follows.

> *By placing land out of bounds, open space constraints "push" urban growth away from them and therefore in a different direction. By locating in specific areas and along specific routes, public infrastructure "pulls" urban growth toward those areas and therefore away from other locations where it does not already exist.*

Urban containment policies with "push" factors include greenbelt and urban growth boundaries. Urban containment policies with "pull" factor include urban service areas. That is, the purposes of urban containment policies ("push" and "pull" factors) are to accomplish a more efficient utilization of land in metropolitan areas. The UGB is a legal boundary separating urban land from rural land. The boundary is set in an attempt to control urbanization, by designating the area inside the boundary for higher density urban development, and the area outside the boundary for lower density rural development (Pendall et al., 2002).

Kain (1968) asserts that suburbanization after WWII separated the housing market as well as segregating jobs and housing. J-H mismatch (or imbalance) can also cause longer commuting, which affects traffic congestion and air pollution. In general, the J-H balance can be represented as the J-H ratio. The J-H ratio is the ratio of the number of jobs to the number of housing units. An area is considered imbalanced when the number of jobs far exceeds the number of housing units, or the number of housing units far exceeds the number of jobs (Cervero, 1991; Giuliano, 1991). Wang (2000) defines J-H balance as "the (dis)parity between the number of jobs and housing units within a geographical area." In addition, Levine (1998) notes that the number of jobs and the number of housing units are to be equally balanced in cities, finding an equilibrium. Burby and Weiss (1976) also define a balanced region as "a self-reliant one, within which people live, work, shop, and recreate."

Then, what is the relationship between J-H imbalance and suburbanization? Giuliano (1991) demonstrates that most municipalities are balanced, except sub-regional areas, where the J-H relationship is imbalanced, because the area is rapidly grown. It can be said that suburbanization causes the J-H imbalance (Kain, 1968; Giuliano, 1991; Cevero, 1991, 1996). In addition, a J-H imbalance causes problems of congestion, increased commuting time, air pollution, increases in the construction cost of infrastructure and in social cost, and so on. Therefore, Wang (2000) and Park and Kwon (2009) assert that the J-H ratio can be a good indicator of suburbanization, because it well represents the balance of residential and employment conditions.

Based on the functional relationship between commuting time and the J-H ratio of different income groups, this study analyzes the following hypotheses, because if the compact city (or urban containment policy) beneficially affects social equity, the difference of the functional relationship between commuting time and the J-H ratio of different income groups will be smaller than for other cities.

Hypothesis 1: There will be a trade-off relationship between commuting time and J-H ratio.

Hypothesis 2: The UGB will affect the urban spatial structure of different income levels.

Hypothesis 3: Portland metropolitan urban growth management will affect the urban spatial structure of different income levels.

3. METHODOLOGY AND ANALYSIS

3.1. Case Areas and Data

To compare the functional relationship, three metropolitan areas (Portland MSA, Cleveland MSA, and Seattle MSA) were analyzed based on the populations of year 2000 census data from the Federal Communications Commission (FCC)[2]. This was because there are two reasons. First, the population size in the three regions is similar (i.e., Seattle: 2,414,616; Cleveland: 2,250,871; and, Portland: 1,918,009). Second, the Portland MSA has a unique government system and urban containment policy[3] (i.e. Metro and UGB), and the Seattle MSA has also urban containment policy, while the Cleveland MSA does not. According to Wassmer (2006), the start year of UGB in the Portland MSA (1980) is different from the Seattle MSA (1992). Therefore, this study can analyze the time effect of urban containment policy on the urban spatial structure of different income levels by comparing the two regions.

According to the FCC, the Seattle metropolitan area ranked as the nineteenth largest MSA, with a population of 2,414,616 (Census, 2000). The Seattle metropolitan area includes the city of Seattle, King County, Snohomish County, and Pierce County within the Puget Sound region. However, in this study, Pierce County was excluded because the FCC divided it into two metropolitan divisions. The Cleveland metropolitan area, the twenty-fourth largest in the U.S., consists of five counties: Cuyahoga County, Geauga County, Lake County, Lorain County, and Medina County, and has a population of 2,250,871 (Census, 2000). The Portland Metropolitan Statistical Area (MSA), the twenty-eighth largest in the U.S., has a population of 1,918,009 (Census, 2000). It consists of Multnomah, Washington, Clackamas, parts of Columbia, and Yamhill counties in Oregon, as well as Clark County and Skamania County in Washington.

This study uses CTPP (Census Transportation Planning Package) Data 2000, consisting of data on the work place and residential place, to analyze the relationship of J-H balance and commuting of different income groups[4] in the three metropolitan areas in 200. To use the CTPP Data 2000 might be a limitation of this study. In general, the CTPP Data are released once every 10 years. Even though some 2010 data for metropolitan areas are released, the geographic level (i.e., census tracts) is not available. Therefore, this study could not use the 2010 data. However, this study using 2000 data would be a good guideline or an example to

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[2] The Federal Communications Commission (http://wireless.fcc.gov/wlnp/documents/top10.pdf).

[3] "The city of Portland and the Metro implemented the UGB, which is a legal boundary separating urban land from rural land. It shares 32% (i.e., 3,026 square miles) of the Portland metropolitan area. The boundary is set in an attempt to control urbanization by designating the area inside the boundary for higher density urban development and the area outside the boundary for lower density rural development. The Metro, an elected metropolitan government, was developed from the Columbia Region Association of Governments' (CRAG) expansion of functions and member regions in 1979. The Metro and its elected executive officer coordinate, plan, and implement land use, transportation, park and water resources, and waste management in 3 counties and 25 cities (Metro 2009) (Park and Kwon, 2009, p.93)."

[4] There are many methods to identify income groups. This study simplifies income groups because the data are aggregated data. According to U.S. Census Bureau (2001), median income value (2000, dollars) and mean incomes were $ 33,447 and $ 42,41. Therefore, the upper 30% of those values are the high-income group, and the lower 30% of those values are the low-income group. The range of the low-income group is between $0 and $25,000, the range of the median income group is between $25,000 and $75,000, and the range of the high-income group is over $75,00.

studies using 2010 data. To calculate the J-H ratio, data on the number of jobs used in the model was obtained by collecting the data of the work place section, and data of the number of housing units used in the model was obtained by collecting the data of the residential place section. In addition to these statistical techniques, as supplementary analytical methods this research utilizes the Urban Sprawl Index (or Social Equity Index), and GIS techniques as critical tools to measure reasonable J-H ratios.

3.2. Jobs-Housing Ratio

The jobs-housing ratio (J-H ratio) is formulated as the ratio of the number of jobs to the number of houses. It is used as a measure of J-H balance in a region or area. If the value of the J-H ratio is close to 1, this means a balance of J-H. If the value of the J-H ratio is close to 0 or significantly more than 1, this means an imbalance of J-H. However, there are no absolute values of J-H balance. Margolis (1973) suggests that when the range of the ratio of jobs to housing units in a region is from .75 to 1.25, the J-H balance of the area is balanced. Frank (1994) defines J-H balance within census tracts as a J-H ratio of between .8 and 1.2. On the other hand, Cervero (1989) asserts that when the J-H ratio is around 1.5, the area is balanced, because there are two or more workers in one house. Recently Park and Kwon (2009) have proposed and tested the range from 1.0 to 1.5 as a balanced range for the J-H ratio.

As has been discussed in the literature review, urban sprawl is "uncontrolled suburbanization" (Lee and Leigh, 2005). That is, although an urban area grows, there will be no or less urban sprawl phenomenon in a region if the growth of the urban area is 'appropriately' controlled. What then is an appropriate indicator to measure urban sprawl? This is represented as the J-H ratio that has been analyzed and proven in the literature as a 'viable' tool of urban spatial mismatch of socioeconomically-embedded employment and residential opportunities. For instance, if a region is a balanced area, social problems that arise from urban sprawl are expected to decrease to some extent. Therefore, the J-H ratio is a good indicator for representing the urban sprawl in a region. To synthesize previous studies, Park and Kwon (2009) have recently re-confirmed its viability, by comparing the relationship between J-H ratio and commuting time in three case areas.

3.3. GIS Techniques: The Floating Catchment Area Method

This article uses the floating catchment area method, a GIS technique developed by Peng (1997) for more reasonable measurement of J-H ratios within possible commuting distances from a particular area (Figure I). The floating catchment area for measuring the J-H ratio is a census tract's area whose houses and jobs are caught by the buffer (a circle around its centroid) (Peng, 1997; Wang, 2000; Park and Kwon, 2009). This circle floats from one census tract to another while its radius remains the same. In practice, the floating catchment area is composed of the census tracts whose centroids fall within the circle. The J-H ratio is measured by "the availability of jobs within a certain distance of a residential site, and the ratio of resident workers per job can be calculated for each census tract" (Wang, 2000). Therefore, this technique can minimize the bias arising from measuring a J-H ratio in a census tract. The reasonable range for defining catchment areas in the case areas is usually 5.0 - 12.5 miles (Peng, 1997; Wang, 2000; Park and Kwon, 2009).

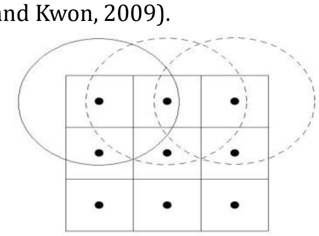
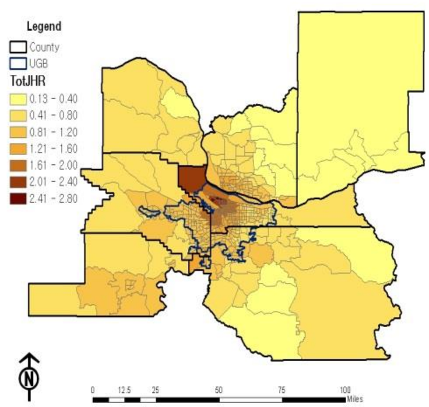


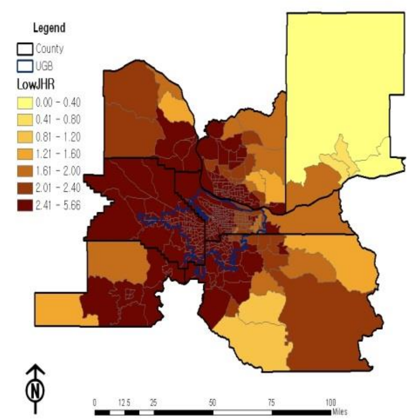
Figure I. The Floating Catchment Areas Method for Measuring the J-H Ratio

Note: The circle denotes a floating catchment area. The rectangle with a dot at its center represents a tract centroid.

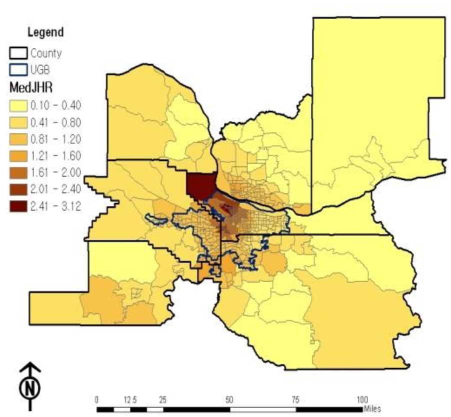
Figures II, III, and IV show the J-H ratios of different income groups in three metropolitan areas. The total J-H ratio in the three areas is similar to the J-H ratio of the median income group in the three areas, because the median income group dominates the three areas. The total J-H ratio and the median J-H ratio in the three areas show general patterns: the J-H ratio in the CBD is higher, and the J-H ratio in suburban areas is lower. Hence, these J-H ratios show suburbanization patterns. The high J-H ratio and the low J-H ratio in the three areas show contrasting patterns. The maps of both income groups show a higher spatial mismatch. These patterns support the functional relationship between commuting time and J-H ratio of the different income groups. That is, the maps of both income groups have different means from each other. The high-income group wants to live in a good residential environment, indicating a lower J-H ratio. On the other hand, the low-income group wants to live in job rich areas for seeking jobs, representing a higher J-H ratio.



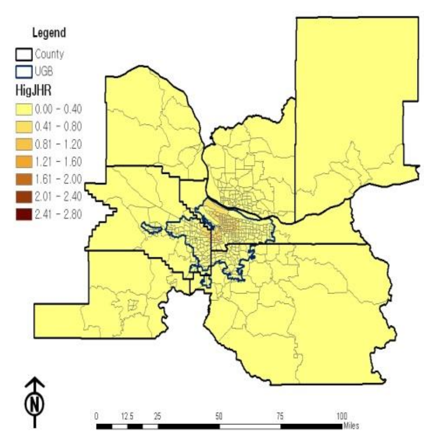
a. Total J-H Ratio



b. Low-income group J-H Ratio

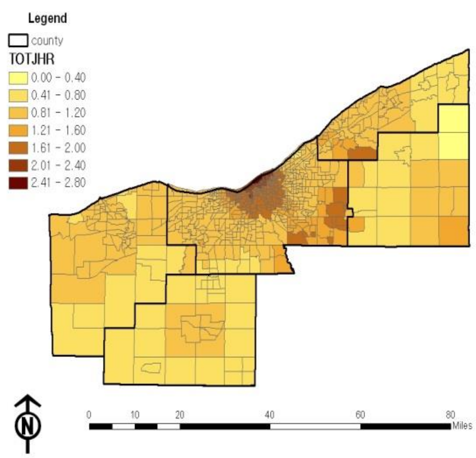


c. Median Income Group J-H Ratio

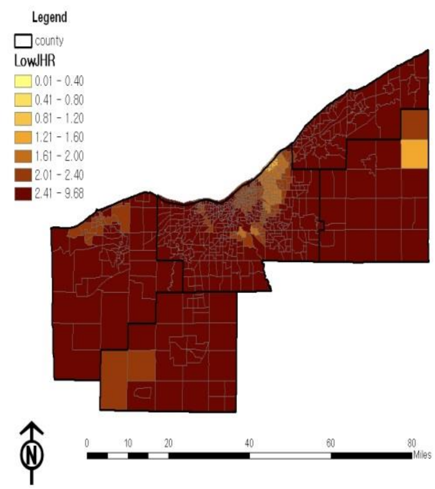


d. High-income group J-H Ratio

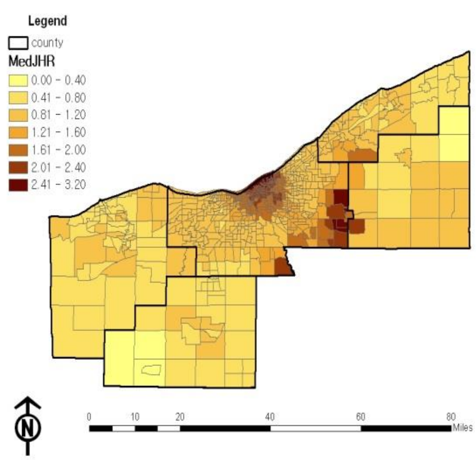
Figure II. The Jobs-Housing Ratio in Portland MSA



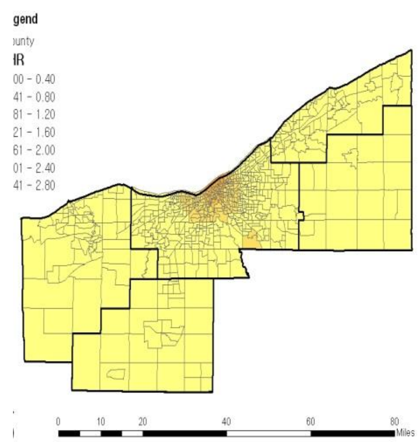
a. Total J-H Ratio



b. Low-income group J-H Ratio

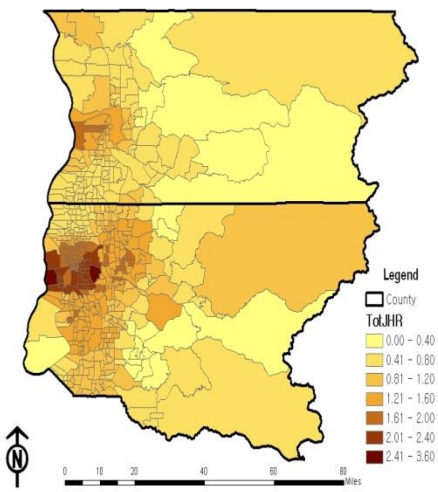


c. Median Income Group J-H Ratio

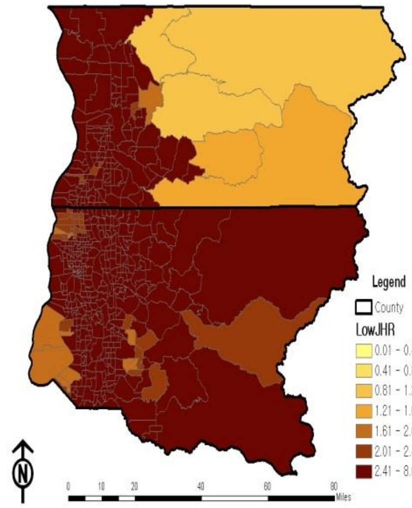


d. High-income group J-H Ratio

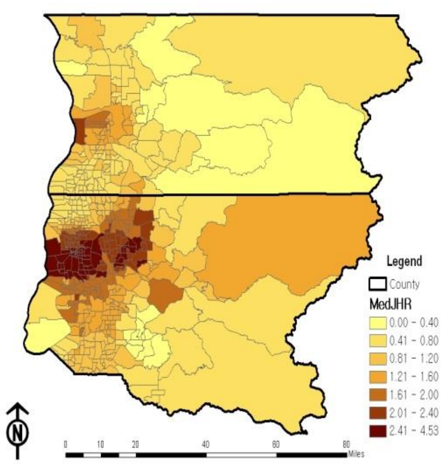
Figure III. The Jobs-Housing Ratio in Cleveland MSA



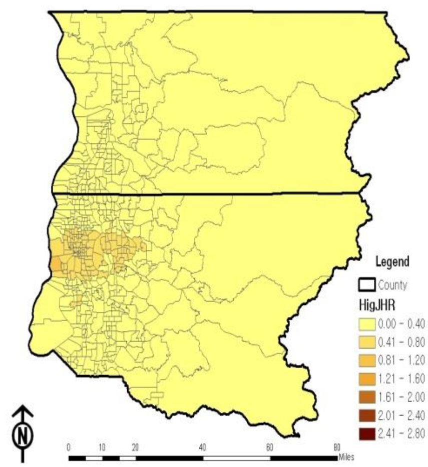
a. Total J-H Ratio



b. Low-income group J-H Ratio



c. Median Income Group J-H Ratio



d. High-income group J-H Ratio

Figure IV. The Jobs-Housing Ratio in Seattle MSA

4. ANALYSIS AND RESULTS

To test the 3 hypotheses, this study conducted three polynomial regression models to empirically analyze the relationship between the J-H ratio and the commuting time in the three case areas. In general, when a polynomial regression model is conducted, a multicollinearity problem is caused. Cohen et al., (2003) introduce a centering predictor method[5] for solving the multicollinearity problem. Therefore, this study uses the centering predictor method.

[5] The centered linear predictor x is $(X – M_X)$, and the centered quadratic linear predictor x^2 is $(X – M_X),^2$

Hence, to see if J-H ratio, UGB, and Portland metropolitan urban growth management have an increasing or decreasing effect on commuting time, consider the following models:

(1) $$CT_{ij} = \alpha + \beta_1(JHR_{ij} - \overline{JHR_{ij}}) + \beta_2(JHR_{ij} - \overline{JHR_{ij}})^2 + \mu$$

(2) $$CT_{PDXj} = \alpha + \beta_1(JHR_{PDXj} - \overline{JHR_{PDXj}}) + \beta_2(JHR_{PDXj} - \overline{JHR_{PDXj}})^2 + \beta_3 Dummy_{UGB} + \mu$$

(3) $$CT_{Pooledj} = \alpha + \beta_1(JHR_{Pooledj} - \overline{JHR_{Pooledj}}) + \beta_2(JHR_{Pooledj} - \overline{JHR_{Pooledj}})^2 + \beta_3 Dummy_{CLE} + \beta_3 Dummy_{SEA} + \mu$$

where

CT_{ij} = average commuting time of *j* income group in *i* metropolitan area
CT_{PDXj} = average commuting time of *j* income group in Portland metropolitan area
$CT_{Pooledj}$ = average commuting time of *j* income group in all metropolitan area
JHR_{ij} = J-H ratio of *j* income group in *i* metropolitan area
$\overline{JHR_{ij}}$ = The average of J-H ratio of *j* income group in *i* metropolitan area
$Dummy_{UGB}$ = UGB dummy variable
$Dummy_{CLE}$ = Cleveland dummy variable
$Dummy_{SEA}$ = Seattle dummy variable.

In the first model, Eq. 1 tests whether there are functional relationships (Hypothesis 1) between commuting time and J-H ratio, because the functional relationship can explain the other two hypotheses. In the second model, Eq. 2 examines whether there is a direct effect of the urban growth boundary on the urban spatial structure of different income groups (Hypothesis 2). In the third model, Eq. 3 examines whether there are significant differences between Portland MSA and the other two MSAs of urban spatial structure of the different income groups (Hypothesis 3).

Table I shows descriptive statistics. The number of observations of each MSA for analysis is 426 (Portland), 682 (Cleveland), 506 (Seattle), and 1614 (all MSA). The average commuting time (minutes) and the J-H ratio of all the MSA is 25.86 minutes and 1.15 respectively. In addition, the range of the J-H ratio in all MSAs is within the balanced ranges mentioned in the literature. The total average commuting time and the total J-H ratio for Portland are lower than for other areas. In addition, the average commuting time and the J-H ratio of the low-income group in Portland is the lowest.

All regression results show that variables related to the J-H ratio are highly significant. The slope coefficient of the J-H ratio is negative, but the coefficient of the J-H ratio-squared variable is positive. These results indicate that the functional relationship between commuting time and J-H ratio has a trade-off relationship. This result proves the first hypothesis of this paper.

Table I. Descriptive Statistics of Variables

Area	***Portland MSA***			***Cleveland MSA***			***Seattle MSA***			***Pooled Data***		
	#	*Mean*	*Std.*	*#*	*Mean*	*Std.*	*#*	*Mean*	*Std.*	*#*	*Mean*	*Std.*
Total Time	*426*	*24.3935*	*3.8723*	*682*	*25.3749*	*3.8021*	*506*	*27.7471*	*4.2936*	*1614*	*25.8595*	*4.1965*
Low Time	*426*	*22.7161*	*3.6541*	*682*	*23.0208*	***4.8967***	*506*	*24.6326*	*3.6598*	*1614*	*23.4457*	*4.3004*
Median Time	*426*	*25.7279*	*4.9304*	*682*	*25.7887*	*4.8713*	*506*	*29.1464*	*5.2713*	*1614*	*26.8253*	*5.2522*
High Time	*426*	*23.7284*	*8.8544*	*682*	*23.1568*	***12.2016***	*506*	*28.5659*	*9.2430*	*1614*	*25.0035*	*1.7756*

where, M_X is the mean of *X*. By using this method, the multicollinearity problem is removed. See Appendix 1.

Low JHR	*426*	*3.0285*	*.7433*	*682*	*3.1831*	***1.2569***	*506*	*3.5266*	*1.1305*	*1614*	*3.2500*	*1.1187*
Median JHR	*426*	*1.1000*	*.5372*	*682*	*1.2358*	*.5138*	*506*	*1.3857*	*.7337*	*1614*	*1.2470*	*.6065*
High JHR	*426*	*.2510*	*.1410*	*682*	*.3348*	***.2506***	*506*	*.2538*	*.1635*	*1614*	*.2873*	*.2044*
Total JHR	*426*	*1.1067*	*.4610*	*682*	*1.1992*	*.4051*	*506*	*1.1250*	*.5072*	*1614*	*1.1515*	*.4556*

Table II shows the direct impact of UGB on the commuting time of different income groups while Tables III and IV show the relationships between commuting time and J-H ratio without considering the effect of UGB. However, the results indicate that the UGB does not have a significant effect on the commuting time of all income groups. We can infer the meaning of the result. Because there is not much construction outside of UGB areas, there are not many people to commute in the UGB area. In other words, the nonsignificant mean of UGB can be interpreted as a positive effect, because the commuting time within the UGB is similar to the commuting time outside of the UGB. This means that people in the UGB commute within the UGB area, and people outside the UGB commute outside the UGB.

Table V shows the effect of Portland metropolitan urban growth management on commuting time by comparison with other MSAs. The results indicate that the Seattle dummy variable is statistically significant, but the Cleveland dummy variable is not significant. The reason for non-significance of the Cleveland dummy variable is the extreme outliers. As shown in the descriptive statistics, the standard deviation of commuting time and J-H ratio for Cleveland is larger than for other areas. Although the Cleveland dummy variable is not significant, the coefficient of both variables is positive. That is, the commuting time in Portland is shorter than in other areas.

In addition, the R^2 of the median income group in all areas except the Cleveland area is higher than for other income groups. The results indicate that the median income group regards the relationship between commuting costs and residential location as an important factor. On the other hand, the R^2 of high and low-income groups is lower. That is, their residential location is more affected by other factors. As mentioned above, when the high-income group decide on their housing, they focus on the living environment in a residential area. But when the low-income group decides on their housing, they are more affected by other factors, such as high moving costs and employment conditions.

Table II. Regression Results for Portland MSA

	Portland Low				***Portland Median***				***Portland High***				***Portland Total***			
	b	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*
Constant	*22.503*		*74.812*	*.000*	*24.708*		*7.446*	*.000*	*23.002*		*29.640*	*.000*	*23.354*		*82.486*	*.000*
Centered JHR	*-1.673*	*-.340*	*-7.200*	*.000*	*-7.164*	*-.781*	*-17.13*	*.000*	*-34.454*	*-.549*	*-9.936*	*.000*	*-6.054*	*-.721*	*-15.949*	*.000*
Centered JHR²	*.152*	*.041*	*.869*	*.386*	*4.113*	*.357*	*8.911*	*.000*	*67.412*	*.196*	*4.112*	*.000*	*4.515*	*.351*	*8.674*	*.000*
UGB Dummy	*.208*	*.028*	*.591*	*.555*	*-.266*	*-.026*	*-.652*	*.515*	*-.990*	*-.054*	*-1.107*	*.269*	*.134*	*.017*	*.405*	*.685*
	R = .347, R² = .120 F (3.425) = 19.207, p < .000				*R = .701, R² = .492 F (3.425) = 136.279, p < .000*				*R = .519, R² = .270 F (3.425) = 51.964, p < .000*				*R = .656, R² = .431 F (3.425) = 106.355, p < .000*			

Table III. Regression Results for Cleveland MSA

	Cleveland Low				Cleveland Median				Cleveland High				Cleveland Total			
	b	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*
Constant	22.419		107.086	.000	25.522		103.23	.000	22.266		36.227	.000	24.888		12.771	.000
Centered JHR	-1.737	-.446	-9.308	.000	-2.768	-.292	-6.279	.000	-19.620	-.403	-7.060	.000	-.396	-.042	-.929	.353
Centered JHR²	.382	.257	5.366	.000	1.011	.073	1.579	.115	14.198	.119	2.091	.037	2.972	.150	3.315	.001
	R = .338, R² = .114 *F (2, 681) = 43.811, p < .000*				*R = .255, R² = .065* *F (2, 681) = 23.526, p < .000*				*R = .320, R² = .102* *F (2, 681) = 38.759, p < .000*				*R = .132, R² = .017* *F (2, 681) = 6.046, p < .00*			

Table IV. Regression Results for Seattle MSA

	Seattle Low				Seattle Median				Seattle High				Seattle Total			
	b	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*
Constant	24.531		137.146	.000	28.091		129.403	.000	27.157		57.988	.000	26.886		148.863	.000
Centered JHR	-1.473	-.455	-8.978	.000	-5.734	-.798	-22.270	.000	-31.756	-.562	-11.669	.000	-6.194	-.732	-19.759	.000
Centered JHR²	.079	.051	1.002	.317	1.964	.269	7.513	.000	52.791	.230	4.775	.000	3.355	.291	7.853	.000
	R = .426, R² = .182 *F (2, 505) = 55.808, p < .000*				*R = .709, R² = .503* *F (2, 505) = 254.577, p < .000*				*R = .469, R² = .220* *F (2, 505) = 7.894, p < .000*				*R = .661, R² = .437* *F (2, 505) = 195.442, p < .000*			

Table V. Regression Results of Pooled Data

	Pooled Low				Pooled Median				Pooled High				Pooled Total			
	b	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*	*b*	*β*	*t*	*p*
Constant	22.197		112.655	.000	24.351		108.837	.000	22.199		45.483	.000	23.338		123.461	.000
Cleveland Dummy	.292	.034	1.183	.237	.859	.081	3.256	.001	.504	.023	.824	.410	1.570	.185	7.077	.000
Seattle Dummy	2.522	.272	9.557	.000	4.420	.391	15.570	.000	4.736	.204	7.443	.000	3.256	.360	13.895	.000
Centered JHR	-1.620	-.421	-14.810	.000	-5.212	-.602	-24.986	.000	-26.694	-.506	-15.833	.000	-4.277	-.464	-19.833	.000
Centered JHR²	.268	.167	5.881	.000	1.974	.215	8.823	.000	26.509	.209	6.469	.000	4.038	.279	11.841	.000
	R = .395, R² = .156 *F (4, 1613) = 74.430, p < .000*				*R = .593, R² = .352* *F (4, 1613) = 218.443, p < .000*				*R = .443, R² = .197* *F (4, 1613) = 98.466, p < .000*				*R =.532, R² = .283* *F (4, 1613) = 158.757, p < .000*			

The Cleveland dummy variable is not significant, because the standard deviation of commuting time and J-H ratio in Cleveland is larger than for other areas. Therefore, to solve this problem, this study utilizes the urban sprawl index (USI) or the social inequity index (SII) to examine the effect of Portland metropolitan urban growth management on the urban spatial structure of different income levels, by comparing it with other regions.

The USI or the SII has been constructed by the operationalization of the central tendency and dispersion of the J-H ratio in relation to the commuting time based on their trade-off relationship, which is tested in Park and Kwon (2009). This study defines and utilizes the USI (or SII)[6] index for formulating a scaled criterion of the degree of urban sprawl or social

[6] This index has two basic assumptions: 1) the commuting time in the less sprawl (or less social inequity) areas will be short (the standard deviation will be small), and 2) the J-H ratio in the less sprawl (or less social inequity) area will be high (the standard deviation will be large).

inequity in the case areas, although it is not an absolute but a relative ratio for the case areas. Based on this relative ratio, each region's (causal) differences will be further and simultaneously analyzed with appropriate variables and constructive indices. The USI (or SII) is formulated as in Eq. 4 as follows:

$$USI(or\ SII)_i = \sum\left(\frac{JHR_{ave_{ij}}}{JHR_{ave_i}} + \frac{JHR_{sd_{ij}}}{JHR_{sd_i}}\right) * \left(\frac{CT_{ave_{ij}}}{CT_{ave_i}} + \frac{CT_{sd_{ij}}}{CT_{sd_i}}\right), \quad (4)$$

where

USI (or SEI)$_i$ = The Urban Sprawl Index or Social Inequity Index in *i* metropolitan area
JHRave$_{ij}$ = the average of J-H ratio of *j* income group in *i* metropolitan area
JHRave$_i$ = the average of J-H ratio in *i* metropolitan area
JHRsd$_i$ = the standard deviation of J-H ratio of *j* income group in *i* metropolitan area
JHRsd$_i$ = the standard deviation of J-H ratio in *i* metropolitan area
CTave$_{ij}$ = the average commuting time of *j* income group in *i* metropolitan area
CTave$_i$ = the average commuting time in *i* metropolitan area
CTsd$_{ij}$ = the standard deviation of commuting time of *j* income group in *i* metropolitan area
CTsd$_i$ = the standard deviation of commuting time in *i* metropolitan area

Table VI shows the SII in three MSAs. The results indicate that for Portland, the SII of each income group, as well as the sum of SII, is the lowest. Therefore, Portland metropolitan urban growth management has had a positive effect on the urban spatial structure of different income levels. That is, Portland metropolitan urban growth management has contributed to social equity.

Table VI. The Social Inequity Index in the Three MSAs

Metropolitan	***Portland***			***Cleveland***			***Seattle***		
Income Groups	*PDX* Low	*PDX* Med	*PDX* Hig	*CLE* Low	*CLE* Med	*CLE* Hig	*SEA* Low	*SEA* Med	*SEA* Hig
X (JHR)	*4.35*	*2.16*	*.53*	*5.76*	*2.30*	*.90*	*5.36*	*2.68*	*.55*
Y (Time)	*1.87*	*2.33*	*3.26*	*2.20*	*2.30*	*4.12*	*1.74*	*2.28*	*3.18*
Index	***8.13***	***5.03***	***1.73***	***12.67***	***5.29***	***3.70***	***9.33***	***6.11***	***1.75***
Sum of Index		*14.89*			*21.66*			*17.19*	

In addition, the results of the relationship between commuting time index (*Y*) and J-H index (*X*) (Figure V) supported the functional relationship of the land use patterns of different income groups.

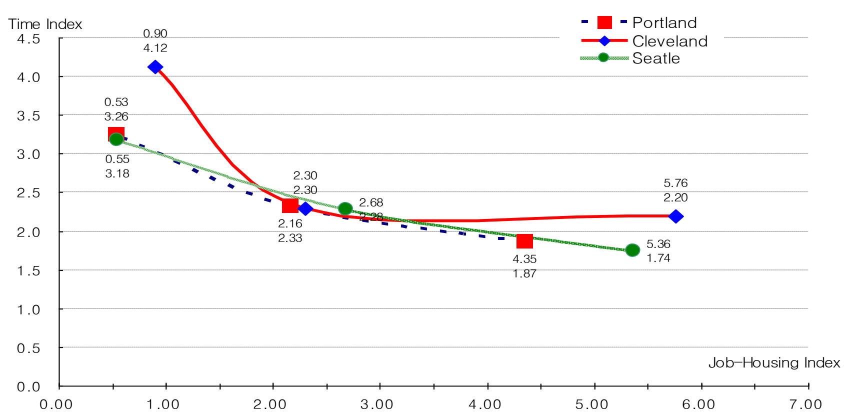


Figure V. The Relationship between Time Index and J-H Ratio in the Three MSAs

Therefore, the high-income group and the median income group decide their residential location with their preference as "a rational locator." However, in the case of the low-income group, they cannot decide their residential location with their preference because of high moving costs (e.g., high housing prices in suburban areas).

5. CONCLUSIONS

Based on contrasting views (planning-oriented vs market-oriented) of urban sprawl and urban containment (or compact city), this study analyzed whether a compact city contributes to social equity, by comparing Portland metropolitan, which is well known as a compact city, to other metropolitan areas.

This study made three hypotheses for analyzing the research question. The first hypothesis was to examine whether the functional relationship between commuting time and J-H ratio can represent the spatial trade-off relationship of the opportunity costs of commuting costs and residential location. The results indicated that the functional relationship has the spatial trade-off relationship. The second hypothesis was to test whether the UGB in Portland has a direct effect on the commuting time of different income groups. Although the results were not significant, it can be explained as a positive effect, because people in the UGB commute within the UGB area while people outside the UGB commute outside the UGB. Therefore, there was no difference in commuting time between within and outside the UGB. Based on the previous two hypotheses, the third hypothesis was to analyze whether Portland metropolitan urban growth management contributes to social equity, by comparison with other metropolitan areas. The results indicated that Portland metropolitan urban growth management contributed to social equity. In addition, as shown in the GIS maps, the spatial mismatch of the low-income group was greater than that of other income groups. That is, the low-income group did not make a rational location decision.

All the analysis results explain the urban spatial structure of the different income groups. The median income group in the three metropolitan areas decided their residential location close to their jobs as a "rational locator" (Levinson and Kumar, 1994). The commuting time of the high-income group in all areas was longer than for other income groups, because they were less affected by transportation costs. That is, in the case of the high-income group, the living environment in their residential area is a more important factor than transportation costs. Therefore, the high-income group also decided their residential location as a "rational locator" (Levinson and Kumar, 1994). On the other hand, the low-income group in all areas did not decide their residential location as a "rational locator", because of socioeconomic conditions, such as temporary jobs, high moving costs, and so on.

Each social inequity index (SII) of all income groups in Portland, as well as the sum of the SII, is the lowest. Hence, Portland metropolitan urban growth management had a positive effect on the urban spatial structure of different income levels. That is, it can be said that Portland metropolitan urban growth management contributed to social equity. Consequently, the argument of market-oriented scholars can be rejected. In addition, future research should examine more regions, to find the desirable ranges of government regulation, because "if only mild measures are needed to restrict urban growth that is slightly excessive, but draconian measures are used instead, consumers are likely to end up worse off" (Brueckner, 2000, p.161).

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Appendix 1. The Tolerance and VIF

	Portland Low		Portland Median		Portland High		Portland Total	
	Tolerance	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*
Centered JHR	.934	1.071	.580	1.725	.567	1.763	.661	1.513
Centered JHR^2	.937	1.067	.749	1.336	.761	1.314	.824	1.213
UGB Dummy	.946	1.057	.742	1.348	.716	1.396	.783	1.277

	Cleveland Low		Cleveland Median		Cleveland High		Cleveland Total	
	Tolerance	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*
Centered JHR	.569	1.758	.637	1.570	.406	2.464	.702	1.424
Centered JHR^2	.569	1.758	.637	1.570	.406	2.464	.702	1.424

	Seattle Low		Seattle Median		Seattle High		Seattle Total	
	Tolerance	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*
Centered JHR	.634	1.578	.769	1.300	.669	1.495	.816	1.226
Centered JHR^2	.634	1.578	.769	1.300	.669	1.495	.816	1.226

	Pooled Low		Pooled Median		Pooled High		Pooled Total	
	Tolerance	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*	*Tolerance*	*VIF*
Cleveland Dummy	.650	1.537	.654	1.529	.636	1.572	.653	1.531
Seattle Dummy	.647	1.546	.640	1.562	.665	1.504	.664	1.507
Centered JHR	.648	1.544	.694	1.441	.488	2.048	.813	1.230
Centered JHR^2	.653	1.530	.680	1.470	.480	2.083	.805	1.242