Title
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Journal
The Annals of Regional Science, 51(3)

ISSN
0570-1864

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Publication Date
2013-12-01

DOI
10.1007/s00168-013-0557-1

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Accepted Version

(Note: Published in *Annals of Regional Science* Vol. 51, No. 3, pp.671-693
The final publication is available at http://link.springer.com)

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Abstract: Land use regulations often delay residential development processes and increase the development costs, although they contribute to addressing market failures and realizing a well-organized urban spatial structure. Raising barriers to development can prevent households from moving in response to either job relocations or job growth at certain locations in a timely manner through restrictions in the local housing supply. This situation may also result in longer commuting distances, times, and costs, as well as greater spatial mismatches. To examine the possible adverse effects of the regulations, this study analyzes how intraregional population–employment interactions vary across metropolitan areas that substantially differ in the restrictiveness of land use regulations. First, an exploratory correlation analysis of 40 large U.S. metropolitan areas reveals that highly regulated regions, particularly those with lengthy approval processes, are likely to show a lower correlation between census tract-level population and employment changes and an increase in mean commuting time between 1990 and 2000. Secondly, regression analysis suggests that the lower correlation in highly regulated metropolitan areas could be attributed to the limited responsiveness of the population to employment redistribution within the regions.

Keywords: Land Use Regulation, Population–Employment Interaction, Spatial Mismatch, Residential Mobility

JEL Codes: J61, R23, R31, R52

1. Introduction

Unlike other commodities or production factors, the use of land in most societies is more or less under government control, although the property rights systems and intervention approaches vary significantly. In the U.S., land use planning and regulation have been at the core of decentralized government operations since the 1920s when zoning was legitimized as an exercise of police power in Euclid vs. Ambler Realty Co. (1926) and in the Standard City Planning Enabling Act of 1928 (Kaiser and Godschalk 1995; Teitz 1996). Today, most local and regional government bodies manage or control land use in and around their jurisdictional areas using a variety of policy instruments in addition to traditional zoning techniques (Rudel 1989; Platt 1996). According to a recent survey of the 50 largest metropolitan areas in the U.S. conducted by Pendall *et al*. (2006), most municipalities have zoning ordinances (91.5%) and comprehensive plans (84.6%), and a considerable number of local governments additionally implement impact fees (37.5 %), adequate public facilities ordinances (18.6%), and urban containment policies (16.4%).

The prevalent government intervention in land use is certainly based on the notion that proper land use controls can enhance public interest by addressing intrinsic market failures involved in land use, such as negative externalities, public goods/services issues, transaction costs, and so forth (see e.g., Moore 1978; Dawkins 2000; Kim JH 2011). Some previous studies, however, report the following potential negative consequences: (1) strict land use regulations can induce the enhancement of land owners' monopoly power, rapid increases in housing prices, and consequent affordable housing problems (Pollakowski and Wachter 1990; Thorson 1996; Quigley and Raphael 2004); (2) the land use regulations implemented by one locality for its own

benefit sometimes generate unfavorable external effects on adjacent communities or the region as a whole (Shen 1996; Buzbee 2005; Kim and Hewings 2012); (3) some types of land use controls (e.g., low-density zoning and building caps) and fragmented political structures are likely to aggravate sprawl, causing a long list of undesirable environmental, fiscal, and social problems (Pendall 1999; Carruthers and Ulfarsson 2002; Ulfarsson and Carruthers 2006; Kim and Hewings 2013).

Furthermore, in recent years, land use regulations have been suggested to affect labor market conditions and thus the performance of a regional economy, as the regulations are likely to constrain housing supply. Glaeser (2006) pinpoints this potential negative effect on labor supply by stating, "No Homes, No People, No Jobs." In other words, strict land use regulations can prevent the region from meeting its growing needs for housing and labor force in a timely manner. Two recent studies (Glaser *et al*. 2006; Saks 2008) have empirically examined this issue and have obtained results at the metropolitan level that suggest the assertions may be true.

Is the same claim valid at the intraregional level? Within a highly regulated region, households may not be able to move in response to new job opportunities at certain locations or to job relocations for several reasons. First, strict regulations on residential development that constrain the location and the density of development can tighten the overall level of household residential mobility by limiting housing supply and consequently inducing substantial housing price increases (see e.g., Pollakowski and Wachter 1990; Malpezzi 1996; Riley 2012). A similar

housing price increase can also be caused by another type of intervention that shift the costs involved in development from the locality to the developers.[1]

Secondly, regulatory actions can delay residential development processes, particularly in terms of obtaining zoning/subdivision approvals or building permits (Mayer and Somerville 2000). In some U.S. cities, more than half a year is needed on average to obtain a subdivision approval due to multiple reviews and hold-ups that could be more efficient while maintaining their contributions. The lengthy processes involved can slow down the provision of housing and thus alter the dynamics of population–employment interaction within a region.

Under certain regulatory regimes, it is also true that a particular type of housing unit may not be provided in some areas. For instance, many communities in the U.S. implement minimum lot-size requirements that restrict the provision of high-density affordable housing units to communities. This restriction can significantly limit the location choice of certain groups of households, particularly low- or medium-income groups that cannot consume a single family house built on a large parcel, due to their limited financial capabilities. Therefore, even if these households are willing to relocate in response to the evolving job locations, they may not be able to make the move. The literature on spatial mismatch suggests that such serious problems may exist in many U.S. cities (Ihlanfeldt 1994; Ihlanfeldt and Sjoquist 1998). A few recent empirical studies have also reported evidence consistent with this possible adverse effect of land use regulations (e.g., Shen 1996; Levine 1998 and 2006; Pendall 2000; Ihlanfeldt 2004).

[1] The literature on residential location choice suggests that local housing market conditions have significant implications on the residential mobility of households (see e.g., Cameron and Muellbauer 1998; Van der Vlist *et al*. 2002; Kim S 2011).

This potential consequence of land use regulations can further result in longer commuting distances, times, and costs, as well as spatial mismatches, given that housing/job locations and commuting are jointly determined (Levinson 1997; Van Ommeren *et al*. 2000; Horner 2007). For instance, if the supply of affordable housing units is significantly limited in suburban communities, many employees working for the increasing number of suburban retailers or other firms may need to travel longer distances every day to work (probably from a central city, where housing units for low- or moderate-income households are available, to suburban communities) due to difficulties in moving into the regulated communities.

This study empirically examines the possible adverse effect of land use regulations in the U.S. context by analyzing 40 large U.S. metropolitan areas. It focuses on how intraregional population–employment interactions vary across metropolitan areas that substantially differ in land use regulations using the following two methods: (1) exploratory correlation analysis and (2) regression analysis. The first method computes the correlation between disaggregated-level population and the employment changes for each of the selected 40 metropolitan areas, and explores whether any notable relationship exists between the correlation and the degree of regulatory barriers to residential development (measured by a land use regulation index). Here, mean commuting time changes, a variable of policy interest that is closely related to the issue, are also considered. The second method uses a regional disequilibrium adjustment framework to closely investigate how the reciprocal interrelationship between population and employment (i.e., the influence of intraregional employment changes on population redistribution and vice versa) differs across regions with different regulation levels. By using these methods, the present study attempts to reveal the relationship between strict land use regulations and intraregional population–employment interactions, so as to support more informed policy decision making

with the consideration of potential side effects as well as well-known benefits land use regulations can bring to us.

2. Explorative Correlation Analysis

How are land use regulations and intraregional population–employment interactions related to each other in reality? Are there any systematic patterns in data that suggest the presence of the hypothesized effect of land use regulations? In this section, these issues are explored through an examination of the relationships among three variables of interest: 1) the region-wide degree of regulatory barriers to residential development, 2) the correlation between disaggregated-level population and employment changes (hereafter, PCh–ECh correlation), and 3) mean commuting time changes. If households really find it difficult to relocate in a highly regulated region as hypothesized, the analysis should reveal a negative relationship between the regulatory barriers and the PCh–ECh correlation and a positive relationship between the regulatory levels and mean commuting time changes.

2.1. Land Use Regulation Index

Pendall *et al*. (2006) and many others have noted that a variety of land use policy instruments has been adopted by local, regional, or state government bodies in the U.S. Also, policy actions (e.g., zoning) often qualitatively and administratively vary in different regions. Therefore, case studies that focus on the effect of a certain land use policy in a particular location for a particular time period are a typical format of research in this area.

Despite the difficulties in comparison and quantification, however, there have been considerable efforts to synthesize a wide range of land use regulations across states in an attempt to quantitatively measure the degree of regulatory actions. The rationale of the synthesis is that these regulations may commonly generate a certain effect, particularly on housing market systems, because they mostly raise barriers to land development by delaying the development process or by increasing the cost of development. Furthermore, the quantification allows comparisons or other types of analyses in order to obtain a generalizable conclusion on the effects of land use regulations – the focus of this analysis.

Among various efforts, the Wharton Residential Land Use Regulatory Index (Linneman and Summers 1991; Gyourko *et al*. 2008) is a notable accomplishment. With the use of some survey instruments and an analysis of other pieces of information (e.g., how long before subdivision approvals are obtained; whether a region or locality implements some land use policy measures), this index is designed to represent the level of regulatory barriers to residential development in U.S. cities and metropolitan areas.

While the Wharton index, as it stands, is often used for cross-sectional studies on the effects of land use regulations, the index is utilized to develop a more comprehensive metric in some other studies. For instance, Saks (2008) combines the Wharton index with a few additional surveys to create a new index that represents the overall degree of various regulatory barriers.[2]

[2] More specifically, Saks (2008, pp.180-181) uses five additional surveys conducted by 1) the International City Management Association, 2) the Fiscal Austerity and Urban Innovation Project, 3) the Regional Council of Governments, 4) the National Register of Historic Places, and 5) the American Institute of Planners. In synthesizing the survey outcomes having distinct coverage, some missing values

By synthesizing multiple survey outcomes, the new index reflects a variety of relevant factors, ranging from the rate and duration of local permit approvals to the strength of growth control and historic site preservation actions that can limit residential development in the area. Furthermore, it takes state-level interventions into account, by utilizing a survey study conducted by the American Institute of Planners (1976), as state governments also play a significant role in shaping development processes at least in an indirect way.

The index developed by Saks (2008) is chosen for this study because of several advantages that it provides. First, it considers a broader range of information, so it may better represent the level of multiple regulatory barriers to residential development, imposed by both the state and local governments. Secondly, the index is readily available for a large number of U.S. metropolitan areas across states, and thus valuable for cross-sectional examinations of land use regulations, while its applicability to a small scale analysis would be limited due to its aggregate nature. Furthermore, it indicates the strictness of land use regulations in the late 1980s, thus providing an appropriate measure for the period from 1990 to 2000, the time span of the present study that also affords access to disaggregated-level population and employment data.

2.2. PCh–ECh Correlation (Correlation between Disaggregated-level Population and Employment Changes)

As explained previously, this study is primarily interested in intraregional population–employment interactions and the variance across regions that substantially differ in land use regulations. In the present exploratory analysis, a simple way of operationalizing and

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in few surveys are estimated through the author's OLS regressions to make the index available for a large number of regions rather than limit it to the places included in all surveys.

quantifying this population–employment interaction within each region is used. In other words, the correlation between population and employment changes between 1990 and 2000 for smaller geographical units (i.e., census tracts) is computed and employed. The 1990–2000 decade is used, as reliable tract-level employment information is not available for 2010. The U.S. Census Bureau stopped its long-form survey in Census 2010, whereas 1990 and 2000 employment information is available in the Census Transportation Planning Package (CTPP).

There is a necessary treatment to be done to derive a better measurement of intraregional population–employment interaction. Consider two contrasting cases: (A) in response to a job increase in a census tract, a group of households relocate to some communities next to the tract having new jobs vs. (B) notwithstanding a job increase in a census tract, households do not or cannot respond to the signal by moving. If the correlation between population and employment changes is computed at the census tract-level, that has a generally smaller scope than the typical labor sheds in metropolitan areas, distinguishing Case (A) from Case (B) is not possible. Therefore, alternatively, the correlation between ΔP and $(I + W) \cdot \Delta E$ is computed. Here, ΔP and ΔE refer to the population and employment change of individual census tracts, respectively. I represents an identity matrix, and W is a row-normalized weight matrix constructed based on tract-level journey to work information, available in the CTPP (i.e., row-normalized flow matrix in which all diagonal elements are zero), so that $(I + W) \cdot \Delta E$ indicates the employment change in the labor market centered on each census tract.

Figures 1 through 3, in which each dot represents a census tract within individual metropolitan areas, show the correlations of the three largest metropolitan areas in the U.S. – 1) New York, 2) Los Angeles, and 3) Chicago – as examples. According to the regulation index, New York is a typical highly regulated region, and it exhibits a quite distinct pattern for the

relationship between the population and employment redistribution processes, indicated by a negative value of the PCh–ECh correlation. In other words, the population and employment increases did not spatially coincide within the region during the 1990s. In contrast, Chicago, a relatively unregulated area in terms of residential development, shows a stronger connection between the tract-level population and employment changes. Los Angeles is between the two in terms of both the regulation index and the correlation.

<< Figures 1, 2, and 3 about here >>

For completeness, the correlation between $(I+W)\cdot\Delta P$ and ΔE instead of that between ΔP and $(I+W)\cdot\Delta E$ is also calculated to determine the extent to which these two variables differ. The computation shows that no significant difference exists between the two (correlation: 0.910). The results of this analysis have also been confirmed to be almost the same in the two cases.

2.3. Mean Commuting Time Changes

Information on the mean commuting time is readily available for U.S. metropolitan areas. Using the CTPP, the changes in mean commuting time based on place of work between 1990 and 2000 are compiled for each region. The value based on place of work, as opposed to that based on place of residence, is chosen to better capture the potential increase in commuting time that can be attributed to the difficulties in moving to the job locations due to limited housing options in and around the place of work.

2.4. Study Areas

The analysis is directed to 40 metropolitan statistical areas (MSAs) or primary metropolitan statistical areas (PMSAs) in the U.S. that meet the following two conditions: (1) the 1990 (initial

year) population is greater than a million, so the number of census tracts (i.e., sample size) is sufficient for the analysis, and 2) the residential land use regulation index is available (Table 1).[3] The 1990 Census definitions of the MSA and PMSA, which correspond to the Saks (2008) index, are used here.

<< Table 1 about here >>

2.5. Outcomes of the Analysis

The relationship between the regulation index (x-axis) and the PCh–ECh correlation (y-axis) is presented in figure 4. Although their relationship is not very strong, the two are negatively associated (correlation = –0.314 and two-tailed p value = 0.048), consistent with the hypothesis.

<< Figure 4 about here >>

Figures 5 and 6 show how the mean commuting time changes are associated with the two variables: the regulation index and the PCh–ECh correlation. As suspected, commuting time changes have a positive relationship with the regulation index and a negative relationship with the intraregional PCh–ECh correlation. This finding indicates that commuting time tends to increase more in highly regulated regions where generally, intraregional population and employment changes are not highly correlated. Notably, commuting time changes are more strongly associated with the regulation index than with the PCh–ECh correlation. This stronger association with the regulation index may imply that the real spatial mismatch between a particular class of jobs and the (affordable) housing supply would be more serious than that

[3] There are six regions, having the 1990 population greater than a million, but not included in this study due to the lack of data. In other words, this study covers 40 out of 46 (approximately 87%) largest metropolitan areas in the U.S.

captured from the correlation between aggregated population and aggregated employment changes.

<< Figures 5 and 6 about here >>

In addition, an examination is made to determine whether the relationships vary by metropolitan size that is measured using 1990 (initial year) population. The purpose is to explore whether the hypothesis may be more valid in certain size categories. The 40 selected study regions are grouped into two categories, (1) those with a population greater than two million and (2) those with a population between one and two million, and the same correlation analysis is conducted for both categories. As summarized in table 2, the relationships are much stronger in relatively small metropolitan areas.

<< Table 2 about here >>

Finally, additional tests are performed to explore whether a particular type of intervention is more or less relevant to the lower PCh–ECh correlation and increasing mean commuting time. As discussed in the introduction, various types of the regulatory barriers may commonly affect intraregional population and employment distributions and thus have an impact on commuting patterns for multiple reasons – i) by impeding residential development processes, ii) by inducing rapid house price increases, or iii) by limiting the provision of affordable housing units in certain areas. However, this does not mean that all approaches to land use control generate the same effects. Rather, the outcome can significantly vary by types of government interventions in land development. Therefore, by checking the relation that is specific to the intervention type for the PCh–ECh correlation and the commuting time change, we can obtain a better understanding of the potential effect from which more informative policy lessons could eventually be drawn. For example, if only a delay in development (due to tardy zoning change or subdivision approval

processes) is determined to matter, it may well be that the potential negative effect of land use regulations on intraregional population–employment interactions can be effectively addressed by reducing the delay through appropriate institutional or procedural reform.

Table 3 presents the results of the additional tests, in which the following four components of the regulation index are utilized individually, as opposed to the aggregated index, to investigate how the relationships vary by types of intervention: 1) months to approve the subdivision; 2) number of growth management techniques; 3) implementation of development fees; and 4) state-level regulatory index.[4] As shown in the table, the relationships appear most apparent when a statistic that represents the time delay in the development process (i.e., months to approve the subdivision) is adopted. Although the directions of the relationships are found to hold in all other cases, the implementation of development fees and the state-level regulatory index turn out to have insignificant correlations. In addition, the number of growth management schemes shows an insignificant relationship with the PCh–ECh correlation, while its correlation with the mean commuting time change is significant at 5 % level. This result, which is consistent with the finding of Mayer and Somerville (2000), may suggest that the delay in development seems to matter most significantly.

<< Table 3 about here >>

3. Regression Analysis

[4] The original data sources of these components of the index are an earlier version of the Wharton index (Linneman and Summers 1991) and a survey conducted by the American Institute of Planners (1976). This information is available through Mayer and Somerville (2000) and Malpezzi (1996).

The exploratory correlation analysis shows that a highly regulated region is more likely to show a low level of intraregional PCh–ECh correlation and an increasing mean commuting time. However, the findings of the correlation analysis do not necessarily mean that the hypothesis (i.e., within a highly regulated region, households tend to be less responsive to the changes in job distributions) can be accepted. The observed lower PCh–ECh correlation may be attributable to uncontrolled factors or employment-side reasons.

This section more closely investigates intraregional population-employment interactions in the 40 metropolitan areas by conducting a set of regression analyses with the use of a regional disequilibrium adjustment framework. The investigation will control for the effects of various household and business location factors and will handle the simultaneity between population and employment changes. By doing so, it would enable the determination of how intraregional population–employment interactions vary across metropolitan areas and provide an understanding of why highly regulated regions tend to show a lower correlation between the tract-level population and employment changes.

3.1. Regional Disequilibrium Adjustment Framework

The regional disequilibrium adjustment model, developed by Carlino and Mills (1987) and further extended by Boarnet (1994a), describes dynamic population and employment change processes with explicit consideration of their interactions (i.e., the potential influence of population on employment changes and vice versa). As well explained in prior studies (e.g., Boarnet 1994a; Mulligan and Vias 2006; Carruthers and Mulligan 2007), the approach assumes that the spatial distributions of population and employment are not in equilibrium but tending to

adjust to an equilibrium point that is moving over time. In this framework, the adjustment process toward the equilibrium state is regarded as the main element of population and employment changes. The adjustment model is also designed to consider the effects of many other determinants of household and business location decisions on population and employment changes.

The model has been widely used in both regional and intraregional studies for a variety of purposes. Among others, population–employment interactions have often been examined based on this model, as it properly separates population–employment interactions from the influences of other location factors and determines whether jobs follow people, vice versa, or both in study areas. For instance, Boarnet (1994b) analyzes the municipal population and employment changes in New Jersey by using a spatial econometric version of the adjustment model and finds that jobs tend to follow people in the study area between 1980 and 1988. Vias (1999) also investigates the population–employment interactions using data for the rural Rocky Mountain region and comes up with a similar result.

Similar to prior research, the present study utilizes the disequilibrium adjustment model to examine intraregional population–employment interactions. However, rather than analyzing a single region, the model is repeatedly applied to the 40 large metropolitan areas in a consistent manner in order to determine how the interaction varies across regions and how the variation is associated with the heterogeneity of land use regulations in different metropolitan areas. If land use regulations really matter, a distinct pattern of population–employment interactions (e.g., a lower responsiveness of population to employment change) can be found in highly regulated regions, in contrast to the areas where the barriers to residential development are relatively low.

The formulation of the operational model can be concisely expressed in the form of a simultaneous equation system, as follows:[5]

$$\begin{aligned}\Delta P_{i,t} &= P_{i,t} - P_{i,t-1} \\ &= H_{i,t} \cdot \beta_P + \chi_P \cdot (I+W) \cdot E_{i,t-1} + \theta_P \cdot (I+W) \cdot \Delta E_{i,t} - \phi_P \cdot P_{i,t-1} + u_{i,t}\end{aligned} \quad (1)$$

$$\begin{aligned}\Delta E_{i,t} &= E_{i,t} - E_{i,t-1} \\ &= B_{i,t} \cdot \beta_E + \chi_E \cdot (I+W) \cdot P_{i,t-1} + \theta_E \cdot (I+W) \cdot \Delta P_{i,t} - \phi_E \cdot E_{i,t-1} + v_{i,t}\end{aligned} \quad (2)$$

where

- the two main variables $P_{i,t}$ and $E_{i,t}$ represent population and employment in census tract *i* at time *t*.
- I and W indicate the identity and row-normalized weight matrix. As done in the correlation analysis, $(I+W)$ is used to consider the spatial extent of labor sheds over census tract boundaries.
- $H_{i,t}$ and $B_{i,t}$ represent a vector of exogenous variables for each dependent variable (i.e., household and business location factors, respectively), and β_P and β_E are the column vectors of the associated parameters.
- χ_P, θ_P, ϕ_P, χ_E, θ_E, and ϕ_E are scalar parameters for the population and the employment variables.
- $u_{i,t}$ and $v_{i,t}$ indicate independent identically distributed errors.

Among others, θ_P and θ_E can represent the intraregional population–employment interaction when other factors are controlled for. θ_p shows the magnitude of the effect of employment changes on population changes. In other words, θ_p indicates how households respond to the

[5] See Boarnet (1994a) and Boarnet *et al*. (2005) for more detailed explanations of the model formulation.

changes in employment conditions within a region. If the significance of θ_p for highly regulated areas is much weaker than that of less regulated areas, the relatively lower correlation between population and employment changes in the regulated regions can be attributed to the limited responsiveness of the population to employment changes, which may be associated with the constrained housing market conditions. In contrast, θ_E represents the reversed case or how businesses respond to the changes in population (i.e., labor force and/or consumers). θ_E may systematically differ by regions with different levels of land use regulations. If this is the case (i.e., if θ_E turns out to be the main reason for the variation in intraregional population–employment interactions across regions), regulations for residential development could not be regarded as the main cause of the looser connection between intraregional population and employment changes in the regulated regions.

3.2. Data

Similar to the exploratory correlation analysis presented above, consideration is given to the 40 large U.S. metropolitan areas that substantially vary in land use regulations. Again, the period of analysis is 1990 to 2000, and a spatial weight matrix (W) that is constructed based on data on tract-level journey to work is used in the estimation for all regions, since this method can better represent the spatial interdependence, involved in the adjustment model, than contiguity- or distance-based weight matrices (Boarnet et al. 2005). In order to control for a range of household and business location factors while ensuring consistency for every metropolitan area, the analyses use the same set of independent variables compiled from 1990 Census, CTPP, and National Highway Planning Network data that are commonly available for all study areas. Table 4 provides a list of the independent variables and their data sources.

<< Table 4 about here >>

3.3. Outcomes of the Analysis

The disequilibrium adjustment model for each region (i.e., Equations 1 and 2) is estimated through the use of a spatial two-stage least squares estimation method, suggested by Kelejian and Robinson (1993). This estimation approach utilizes both independent variables and their first-order spatial lags to develop good instruments for the endogenous variables (i.e., $(I+W)\cdot\Delta P_{i,t}$ and $(I+W)\cdot\Delta E_{i,t}$), and is known to show very acceptable performance in the estimation of spatial cross-regressive simultaneous equation system models (Rey and Boarnet 2004). Table 5 presents the estimation outcomes for Milwaukee, WI PMSA as an example; both θ_p (0.203 **) and θ_E (0.668 *) turn out to be significant and positive. In other words, population and employment follow each other within the metropolitan area, while they are also influenced by some other tract-level household and business location factors.[6]

<< Table 5 about here >>

Such a reciprocal population–employment interaction, however, is not necessarily found in every region. As discussed previously, in some metropolitan areas, households might not be able to follow jobs if the housing supply is not flexible. Location choice factors might also vary significantly by region. In some regions with a rapidly growing Hispanic population, the

[6] As presented in table 5, many independent variables show significant effects on population and employment changes, as expected. Not surprisingly, the percentage of non-White population and the level of housing prices are found to have deterrent effects on population change, whereas a higher income level and a larger tract size (indicating sub-urban or exurban areas) seem to induce population growth. In the case of employment changes the presence of interstate highways turns out to play a significant role.

percentage of Hispanic population in 1990 (i.e., *HISPR*) tends to exhibit very significant positive effects on population growth. Other factors such as housing values and transportation infrastructure can play a critical role in some other areas.

In order to see how intraregional population–employment interactions vary by region, the two key parameters from the 40 large metropolitan areas, estimated through the same procedure, are summarized in table 6 in which the 40 regions are classified into three groups based on their land use regulation index: (1) Less regulated regions: Index < 0, (2) Modestly regulated regions: 0 ≤ Index < 1, and (3) Highly regulated regions: 1 ≤ Index. As shown in the table, the highly regulated regions (i.e., Group 3) are found to be less likely to exhibit significant effects of employment changes on population (i.e., θ_p), although there is no significant difference between the first and second groups. Such a gap is not found in the case of θ_E that shows how businesses respond to the changes in intraregional population distribution. In other words, the analysis outcomes may suggest that the relatively lower correlation between population and employment changes in highly regulated areas could be attributed to the limited responsiveness of the population to employment changes rather than employment-side reasons.

<< Table 6 about here >>

Given that the two largest metropolitan areas, New York and Los Angeles, show insignificant population–employment interactions, one could suspect that this variation may be associated with the size of the metropolitan areas rather than with land use regulations. However, this suspicion is not supported by the estimation results that show that seven out of the ten largest areas (besides New York, Los Angeles, and Boston) exhibit significant and positive effects of tract-level employment changes on the population between 1990 and 2000.

Rather, it appears that regulatory barriers, particularly the lengthy approval processes that delay residential development, are highly associated with the variation. Among the regions, ten metropolitan areas were reported to have approximately 1.5 months to approve subdivision (Mayer and Somerville 2000), and all of the areas exhibit significant, positive θ_p, representing the response of households to intraregional employment redistribution. All five regions with 3 months of the approval processes in Groups 1 and 2 (i.e., St. Louis, Cleveland, Minneapolis, Tampa, and Pittsburgh) are also found to show significant, positive estimated coefficients. In contrast, the metropolitan areas with higher regulatory index levels and/or longer approval periods tend to have insignificant effects of employment changes on population. This may indicate that regulatory barriers to residential development, particularly lengthy approval processes, can prevent households from moving in response to intraregional employment changes, as suspected.

4. Summary and Discussion

In this study, an attempt is made to empirically examine whether land use regulations prevent people from responding to the evolving spatial distribution of employment in a timely manner, by analyzing how intraregional population–employment interactions vary across regions that substantially differ in terms of land use regulations. The results of the explorative correlation analysis indicated that highly regulated metropolitan areas were more likely to show lower levels of correlation between tract-level population and employment changes, and with increasing mean commuting times between 1990 and 2000. In addition, the estimation results of a set of

regression analyses suggested that household relocation processes were less responsive to employment changes in highly regulated areas, particularly those with lengthy approval processes, than relatively less regulated regions. These findings may suggest that regulatory barriers to residential development can limit households' relocation processes and affect the internal dynamics of metropolitan areas.

However, the findings still rest on some of the limitations of this study and thus need to be carefully understood. In the correlation analysis, various factors that may influence the PCh–ECh correlation or commuting time changes were not controlled. Although this issue is partially addressed in the regression analyses, the fixed set of control variables may not be perfect. This study is also limited in the sense that aggregated population and employment, as opposed to households by group and businesses by sector, are modeled. The housing and migration literature clearly documents that household location choice heavily depends on many demographic (e.g., life cycle, household size, etc.) and economic (e.g., income level, one-earner vs. two-earner households, etc.) factors. A great deal of heterogeneity also exists in decision making on the business location because of the differences in production recipes, suppliers, and customers. This issue of aggregation is clearly important as some income groups have no limitations, whereas for lower-income groups, land use regulations may generate significant impediments to relocation. Furthermore, the 10-year time span of the current analysis may not be ideal for obtaining precise estimates of real residential or business relocation dynamics. However, this issue is somewhat inevitable due to the limited availability of disaggregated-level data.

Nevertheless, by showing some empirical analysis outcomes corresponding to the hypothesis, the present research provides land use planners and/or other policy makers with a

meaningful caution about their regulatory actions. Given that strict regulatory barriers may make local housing markets less flexible and may affect intraregional household relocation dynamics, more attention needs to be given to the side effects of the regulations, particularly the impact on the internal spatial structure of the region which is critical for the utility of residents and the efficiency of various economic activities. Reforming administrative procedures to reduce the delay in residential development processes may be required in some regions to mitigate the potential adverse effects. Removing exclusionary zoning ordinances and other similar barriers would also be warranted to address the problem. However, this should not be interpreted to imply that planners' intervention in the land development process is harmful. Rather, what is needed are a balanced view of the benefits and costs of land use regulations, more deliberate decision making in the design and enforcement of regulatory actions, and conscious efforts to minimize the adverse consequences, while maintaining the critical functions of the regulations in the management of complex metropolitan areas.

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