Effects of urban growth controls on intercity commuting

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Abstract

Urban growth controls (land use regulations that attempt to restrict population growth and urban sprawl) have increased housing prices and diverted population growth to uncontrolled cities. Resulting changes in labor supply should induce increased intercity commuting of workers from uncontrolled to controlled cities. This paper examines the effect of growth controls on jobs-housing mismatch (i.e., the mismatch between place of work and place of residency) using data from California cities. The econometric analysis indicates a positive and statistically significant effect.

Keywords: Urban growth control; Land use regulation; Intercity commuting; Jobs-housing mismatch; Labor supply.

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1 Introduction

Many jurisdictions in the US have adopted land use regulations to restrict population growth and urban sprawl. These regulations, also known as urban growth controls (UGC), restrict the supply of new houses, increasing local housing prices. They also restrict the local labor supply by diverting population growth to other places. Assuming decreasing returns to scale, higher wages arise as a result. This wage advantage, along with high housing prices, may induce people to work in the city, but to live in nearby uncontrolled cities, i.e., intercity commuting (IC) may occur as a result of UGC. While the theoretical relationship between UGC and IC was analyzed by Ogura [10], there is a lack of empirical studies on this issue.[1] Anecdotal evidence supports the hypothesis that UGC intensify IC. For example, UGC in Santa Barbara seems to have induced a large proportion of workers to live in nearby cities where the supply of house is less restricted (see "Slow Growth has come at a cost in Santa Barbara", in The Los Angeles Times, 3/6/2006).

The present paper presents an econometric analysis of the effects of UGC on IC. In a related paper, Cervero [3] presents an empirical study suggesting that one of the determinants of jobs-housing mismatches is the existence of housing supply restrictions. His study, however, is limited by the lack of a direct measure of UGC (instead, the proportion of land area zoned for residential use is taken as a proxy for housing construction flexibility) and is restricted to census tracts in the California Bay Area. In contrast, the present work draws data for UGC from the 1989 survey of growth controls in California cities arranged by Glickfeld and Levine [6]. In addition, data for IC in California cities is obtained from the US Census Bureau.

The theory presented above implies that the proportion of workers who commute to outside jobs should be higher in places that have neighboring controlled cities. This hypothesis is tested using an econometric model where IC from one city is explained by the existence

[1] Brueckner [1] surveys previous models of UGC, while Fischel [5] surveys empirical evidence on the effects of controls.

of UGC in the neighboring cities and by other city socio-economic characteristics.[2] In the estimation, IC is measured by the percentage of workers who work outside the place of residence. To measure UGC, an intensity index is constructed by adding up the number of different types of residential construction regulations (e.g., infrastructure and population density requirements, construction permits, urban limit line, etc.),[3] existent in neighboring cities.[4] To control for the fact that closeness should allow more IC, the intensity of UGC in each neighboring city is weighted by the inverse of the distance to the city. For the sake of comparison, the results of a non-weighted version of the estimation is also presented.

In accordance with the theory, the econometric analysis indicate that the proportion of intercity commuters in a city is positively affected by the existence of UGC in neighboring cities. This evidence is robust to variations in the construction of the UGC measure and to changes in the set of explanatory variables included in the econometric model. In addition, the estimated coefficients of the other explanatory variables show the expected signs when statistically significant.

This paper is organized as follows. The next section summarizes the theoretical model that shows how UGC may intensify IC. Section 3 discusses the econometric model, while Section 4 presents the data used. Finally, econometric results are analyzed in Section 5 and concluding remarks are presented in Section 6.

2 The theoretical model

This section presents a simplified version of Ogura's [10] model, focusing on the results that IC can be induced by UGC and that, everything else being the same, the intensity of IC should be positively related to the intensity of UGC. Note that in this model IC emerges

[2]An alternative approach would use the actual commuting flows of workers between cities, but this information is not available for most California cities.

[3]Levine [9] uses a similar type of measure to examine the displacement of housing production due to UGC.

[4]Cities are defined as neighbors if their geographical centers are less than 50 miles away from each other. Alternative thresholds (30 and 70 miles) were considered, generating similar results regarding the effects of UGC on IC.

solely due to the adoption of UGC (other factors that affect IC of workers are ignored).[5]

2.1 Setup

Consider a closed economy with two regions indexed by $i = 0, 1$. There is a linear city in each region, with width one and length $\bar{x}_i$. The central business district (CBD), where production takes place, is located at one of the extremes of the city. Thus, the length corresponds to the distance between the boundary of the urban area and the CBD. The distance between the CBDs of the two cities is D. Urban land is occupied by mobile renters, who demand one unit of land each. Thus, $\bar{x}_i$ equals the city population P_i, and $\bar{x}_0 + \bar{x}_1 = P_0 + P_1 = P$, where P is the total population of renters in this economy.

Renters also consume a numeraire private good. Income is obtained from the supply of labor (one unit is supplied by each renter), which is exchanged for a wage w_j, where j denotes the city of work. In order to work in the CBD of her own city, a renter residing at a distance x_i from the CBD incurs a commuting cost of tx_i, where t represents the unit cost per distance. However, if she works in the CBD of the other city, she incurs an additional cost equal to tD. This setting implies that every renter in one city would incur the same additional commuting cost tD if she decided to work in the other city.[6]

The land rent paid by a renter residing at x_i is $r_i(x_i)$, which is a decreasing function of x_i because individuals are willing to bid more to live closer to their work place in order to avoid commuting costs. In equilibrium, land rents extract all utility differentials related to where individuals live, equalizing renters' utilities everywhere. Utility is derived from the consumption of the non-land good, with the indirect utility function of a renter who lives in

[5]For example, Cervero (1989) notes that some jobs-housing mismatch is expected due to the existence of households composed by couples who have to work in different cities, and to the higher frequency of job turnover relative to residential mobility.

[6]This setting is needed to keep the analysis restricted to the case of a monocentric city model with similar individuals.

city i and works in city j being

$$u_{i,j}(x_i) = \begin{cases} w_i - tx_i - r_i(x_i) & \text{if } j = i \\ w_j - tD - tx_i - r_i(x_i) & \text{otherwise.} \end{cases} \tag{1}$$

Land ownership in and around each city is shared among absentee landowners. To simplify, assume that each landowner receives rents from only one of the regions. Normalizing non-urban land rent to zero, total land rent in each region (denoted R_i) can be represented by:

$$R_i\left(\bar{x}_i\right) = \int_0^{\bar{x}_i} r_i(x_i)dx_i. \tag{2}$$

Cities are symmetric in all aspects, except that landowners are politically dominant only in city 0, adopting UGC, i.e., restricting the city size $\bar{x}_0$, to maximize R_0.[7]

Finally, production in each city follows the aggregate function $F(N_i)$, where N_i is the number of workers in city i, with $F'(N_i) > 0$ and $F''(N_i) < 0$ (production exhibits decreasing returns to scale).[8] In addition, $F(0) = 0$ and $F'(0) = +\infty$. Therefore, in equilibrium, profit maximization by competitive firms implies

$$w_i = F'(N_i), \tag{3}$$

resulting in a positive total profit

$$\Pi_i = F(N_i) - N_i F'(N_i) > 0. \tag{4}$$

To simplify, assume that profits are shared among absentee firm-owners, who are neither workers nor landowners.

[7]Other motivations for UGC are discussed in Ogura [10].

[8]Production is carried out by competitive firms, each one producing according to the function $f(L)$, which is strictly concave in L, the number of workers employed. Adding up the production of a finite number of firms k, the aggregate function is $F(N_i) \equiv kf(N_i/k)$, which has the properties mentioned in the text.

2.2 Growth controls in city 0

To understand the adoption of UGC and its effects, first consider the case of no controls. In this case, there are three equilibrium conditions. First, land rent at the boundary of each city must equal the opportunity cost of land outside the city, which is zero. Thus, in city i, $r_i(\bar{x}_i) = 0$. Second, rents at other places in city i are determined by utility equalization: $u_{i,h}(x_i) = u_{i,h}(\bar{x}_i)$ for all x_i and for any $h \in \{i, j\}$. Consequently,

$$r_i(x_i) = t\left(\bar{x}_i - x_i\right). \tag{5}$$

Equation (5) implies that land rent extracts the commuting cost differential with respect to the boundary resident in the city. Finally, utility must also be equalized across cities due to free mobility. Thus, $u_{0,0}(\bar{x}_0) = u_{1,1}(\bar{x}_1)$. Substituting (3), (5), and the population constraint $\bar{x}_1 = (P - \bar{x}_0)$ in (1), this equilibrium condition becomes $F'(N_0) - t\bar{x}_0 = F'(P - N_0) - t(P - \bar{x}_0)$, which is satisfied when $\bar{x}_0 = \frac{1}{2}P$ (i.e., a symmetric population distribution).[9] Thus, there is no IC.

Now, suppose that UGC exists in city 0 (i.e., $\bar{x}_0$ is restricted to below $\frac{1}{2}P$) to increase total land rents. There is no control in city 1, and therefore the land rent function (5) still applies for that city. For city 0, however, there is a change in the land rent function. Recall that residents must be equally well-off in the two cities and suppose for the moment that IC does not occur, meaning that the first expression in (1) is valid. Noting that $u_{1,1}(\bar{x}_1) = w_1 - t\bar{x}_1$, set this expression equal to $u_{0,0}(x_0) = w_0 - tx_0 - r_0(x_0)$ to get

$$r_0(x_0) = t\left(\bar{x}_1 - x_0\right) + w_0 - w_1 = t\left(P - \bar{x}_0 - x_0\right) + F'(N_0) - F'(P - N_0), \tag{6}$$

where the second equality uses $\bar{x}_1 = P - \bar{x}_0$ and (3). In words, equation (6) implies that land rents in city 0 extract two utility differentials: the first term $(t\left(\bar{x}_1 - x_0\right))$ is the commuting

[9] The symmetric allocation is also the social optimum because the total surplus in this economy equals production minus commuting costs, being optimized at the symmetric outcome.

cost differential with respect to the boundary resident in city 1 and the remaining terms $(w_0 - w_1)$ represent the wage differential between cities. When $\bar{x}_0$ is reduced, there is an increase in these two components of land rents at an interior location in city 0. The commuting cost differential increases due to the population relocation to city 1, which raises land demand there, enlarging city size $\bar{x}_1$. City 0's wage advantage is increased because labor supply is restricted in city 0 (while the opposite happens in city 1). Figure 1 illustrates the effects of controls on land rents in each city. In the Figure, note that initially $r_0(0) = t\bar{x}_1 + w_0 - w_1$ and $r_1(0) = t\bar{x}_1$, with the slopes of the land rent curves being $-t$ (from equations (5) and (6)). As city 0's size is reduced from $\bar{x}_0$ to $\bar{x}'_0$, rents in city 0 increases for the two reasons previously mentioned. Areas B and B_1 depict the increase in land rents in each city due to the higher demand for land in city 1 (the city population increases from $\bar{x}_1$ to $\bar{x}'_1$). Changes in labor supply widens the wage differential to $w'_0 - w'_1$, further raising land rents in city 0 (see area C). However, controls also generate a boundary rent loss because there are fewer renters in the city (in the Figure, area A is lost).

[Figure 1]

[Figure 2]

However, the possibility of IC imposes an upper limit to the wage differential between cities because labor from city 1 would flow in if the wage advantage exceeded the IC cost tD. Once it reaches tD, the wage differential becomes constant, being constrained by a perfectly elastic supply of intercity commuters from city 1. Figure 2(a) shows the labor supply curve shifting to the left as controls restrict labor supply in the city (i.e., $\bar{x}_0$ is reduced to below $P/2$). As a result, the wage increases from w_0^1 to w_0^2. However, if the wage advantage reaches tD, IC starts, i.e., the labor supply curve becomes horizontal (see Figure 2(b), where $\hat{w}_0$) is the wage level that makes the wage advantage to be tD) and the equilibrium number of workers in the city is $\hat{N}_0$ regardless of UGC. On the other hand, the number of intercity commuters $(\hat{N}_0 - \bar{x}_0)$ is positively related to the tightness of UGC. Formally, note that once IC starts, the equilibrium size of city 0's workforce $(\hat{N}_0)$ is determined by the equality of the wage advantage to the IC cost:

$$F'(\hat{N}_0) - F'(P - \hat{N}_0) = tD. \tag{7}$$

Several conclusions are evident from (7). First, recall that $N_0 = \bar{x}_0$ in the absence of IC, and suppose that $\bar{x}_0 \geq \hat{N}_0$ holds. Hence, the intercity wage differential in the absence of IC equals $F'(\bar{x}_0) - F'(P - \bar{x}_0) < tD$ (given $F'' < 0$), i.e., IC is relatively too costly, so that no incentive for IC exists. On the other hand, if $\bar{x}_0 < \hat{N}_0$ holds, the wage advantage tends to exceed tD, but then IC occurs instead, making the local workforce ($\bar{x}_0$ residents) be supplemented by intercity commuters ($\hat{N}_0 - \bar{x}_0$ workers from city 1), with a total employment of $\hat{N}_0$. Noting that $\hat{N}_0$ that satisfies (7) must itself satisfies $0 < \hat{N}_0 \leq \frac{1}{2}P$ (given $F'' < 0$), the labor force in city 0 is given by

$$N_0 = \begin{cases} \bar{x}_0 & \text{if } \hat{N}_0 \leq \bar{x}_0 \leq \frac{1}{2}P \\ \hat{N}_0 & \text{if } 0 \leq \bar{x}_0 < \hat{N}_0. \end{cases} \tag{8}$$

It is important to note that $\hat{N}_0$ is solely determined by tD, with $\frac{d\hat{N}_0}{dD} < 0$, meaning that the smaller the IC cost for outsiders, the larger the size of N_0 at which IC commences.

Now, turn back to the landowners' problem in city 0, which is to maximize total land rents (2). Note that the rent function (6) depends on the labor supply function (8). Thus, the problem can be written as

$$\underset{0 \leq \bar{x}_0 \leq \frac{1}{2}P}{Max} \; R_0(\bar{x}_0) = \begin{cases} \int_0^{\bar{x}_0} \left[t\left(P - \bar{x}_0 - x_0\right) + F'(\bar{x}_0) - F'(P - \bar{x}_0)\right] dx_0 & \text{if } \hat{N}_0 \leq \bar{x}_0 \leq \frac{1}{2}P \\ \int_0^{\bar{x}_0} \left[t\left(P - \bar{x}_0 - x_0\right) + tD\right] dx_0 & \text{if } 0 \leq \bar{x}_0 < \hat{N}_0, \end{cases} \tag{9}$$

with condition (7) being used in the second expression to replace the intercity wage differential by the IC cost. Note that if IC were not possible, then $N_0 = \bar{x}_0$ for all $\bar{x}_0$, implying that the first expression of $R_0(\bar{x}_0)$ in (9) would be valid in the entire range $[0, \frac{1}{2}P]$. Comparing the two expressions in (9), the first is always larger in value for $\bar{x}_0 < \hat{N}_0$ because $F'\left(\bar{x}_0\right) - F'\left(P - \bar{x}_0\right) > tD$ in this range of $\bar{x}_0$, as argued before. Since the second expression is valid when IC occurs, it can be concluded that land rents $R_0(\bar{x}_0)$ are restrained by the occurrence of IC.

2.3 Equilibrium characterization

To characterize the solution of problem (9), first notice that the objective function is not differentiable at $\bar{x}_0 = \hat{N}_0$ even though it is continuous there. To simplify, assume that the two expressions in the objective function in (9) are strictly concave in the entire relevant range of $\bar{x}_0$, a condition that is automatically satisfied when the production function is quadratic or exponential. Concavity implies that the equilibrium city size (denoted $\bar{x}_0^*$) is either an interior solution in the range $0 \leq \bar{x}_0 < \hat{N}_0$, or a corner solution at $\hat{N}_0$, or an interior solution in the range $\hat{N}_0 \leq \bar{x}_0 \leq \frac{1}{2}P$. IC occurs only in the first case. In the corner solution case, IC does not occur, but the possibility of IC restrains the adoption of controls. Finally, in the third case, IC does not become imminent, so the adoption of controls is not affected by the possibility of IC.

It can be shown that the size of the IC cost (tD) determines which equilibrium case prevails.[10] In equilibrium, IC occurs ($\bar{x}_0^* < \hat{N}_0$) when the IC cost is small. In this case, the optimum city size is the interior solution obtained by setting the derivative of the second expression in (9) equal to zero:

$$\bar{x}_0^* = \frac{1}{3}\left(P + D\right). \tag{10}$$

For the present paper, the most relevant empirical implication of the model is derived from (10). First, note that $\frac{d\bar{x}_0^*}{dD} = \frac{1}{3} > 0$, i.e., the intensity of UGC weakens as the IC distance increases.[11] Together with $\frac{d\hat{N}_0}{dD} < 0$ (from 8), this result implies that $\frac{d(\hat{N}_0 - \bar{x}_0^*)}{dD} < 0$, i.e., the number of intercity commuters decreases with distance.

Note that controls are chosen to maximize land rents in the theoretical model, but in

[10] See Ogura [10] for the demonstration.

[11] This may not seem intuitive at first, but note that when IC occurs, the wage advantage (which is one of the components of land rents in city 0) equals tD. Thus, the larger is D, the greater is the rent loss due to tighter controls. Therefore, the incentive to adopt controls is reduced as D increases.

practice each jurisdiction may have additional reasons to adopt UGC. Since the focus of this paper is not on the determinants of UGC, the empirical estimation takes the intensity of controls as given. Noting that $\hat{N}_0$ is solely determined by the IC cost, it can be concluded that, controlling for distance D, the number of intercity commuters is positively related to the tightness of UGC. This is the relationship tested in the empirical part of this work.

Finally, when the IC cost is sufficiently large, there is no IC in equilibrium. The corresponding analysis will be omitted here, but it is important to mention that the intensity of UGC increases with D in this case.[12] Thus, a problem could arise in the estimation because there is no positive relationship between the intensity of UGC and IC. Fortunately, all cities considered in the estimation have neighbors close enough to allow IC to occur.

3 The empirical model

The estimation attempts to test the hypothesis that UGC intensify IC. As argued before, controls in a city restrict the labor force size there, increasing wages, and then attracting workers from outside. Since for most California cities there is no available information on the inflow of workers, the estimation uses data on the outflow of workers from the US Census Bureau. According to the theory, the outflow (i.e., IC) should be larger when neighboring cities have UGC. To test this hypothesis, the following empirical model was adopted:

$$y_i = \alpha \sum_{h \neq i} W_{h,i} ugc_h + \sum_{j=1}^{J} \beta_j x_{ji} + v_i, \tag{11}$$

where i refers to city i, y_i is the dependent variable that represents IC, ugc_h is the intensity of controls in the neighboring city h (cities are considered as neighbors if their geographical centers are less than 50 miles away from each other), and x_{ji} are other socio-economic explanatory variables (there are J such variables). $W_{h,i}$ is a weight on the intensity of UGC

[12] Intuitively, when the IC cost is high, tighter controls can be imposed without raising wages high enough to attract workers from outside.

in city h. Two weighting schemes are considered in this work. In Model A, $W_{h,i} = \frac{1}{d_{i,h}}$ if $0 < d_{i,h} < 50$, where $d_{i,h}$ is the distance between cities i and h, implying that larger weight is given to growth-control measures adopted in closer cities. The weight is zero for cities that are far from i, i.e., $W_{h,i} = 0$ if $d_{i,h} \geq 50$. This weighting scheme is justified by the argument that IC should be more intense when cities are closer, i.e., for the same intensity of controls, a closer city should attract more workers. Alternatively, for the sake of comparison, Model B has the same weight assigned to all neighboring cities, i.e., $W_{h,i}$ equals 1 if $0 < d_{i,h} < 50$ and 0 otherwise. Finally, α and β_j are the estimated parameters of the model, while v_i is the unexplained residual. The expected sign for α is positive, since y_i (i.e., IC) is expected to increase with the intensity of control measures in surrounding cities. The expected signs of β_j are explained below.

As additional explanatory variables, other socio-economic characteristics of the city are considered. The demographic variables are: race, age, gender, education, marital status, and house ownership.[13] Race is included because minorities tend to cluster in the residency choice, either due to housing discrimination (see Cutler, Glaeser, and Vigdor, 1999, who study the formation of ghettos) or to preferences (see Gonzales, 1998, who studies Mexican neighborhoods), thus the proportion of intercity commuters should be higher in cities with large presence of minorities. Age structure can impact IC because workers with children should commute less far due to the need to be available during the day, while older professionally established workers should find it easier to relocate near their workplaces, avoiding IC. More household responsibilities for women could lead them to choose shorter journeys to work relative to men, thus the proportion of women should affect the intensity of IC. Higher education (and thus productivity) should induce workers to live closer to their jobs because of the higher marginal opportunity cost of commuting time. Finally, single people

[13] These variables were selected based on the economic literature on the determinants of commuting time (see Lee and McDonald [8] for a recent empirical paper with references to the literature). While this literature studies only individual commuting time, commuting to other cities is probably more time consuming on average. Thus, it is plausible that aggregate versions of the explanatory variables used in that literature should help to explain IC.

and renters are more mobile, thus it should be easier for them to reside in the city where they work. In addition, other city characteristics were also added. Area is included as a proxy for the average distance from the place of residence to other cities (i.e., larger area should restrict IC). Local government employment opportunities may keep more residents working in the city. On the contrary, a high unemployment rate might indicate that it is hard to find jobs at the home city, thus inducing residents to search for job elsewhere. Finally, the size of the job market (measured by the number of workers) is used as a proxy for the availability of job opportunities, implying that if the city's job market is larger, more residents should work there, while if the neighboring cities' job market is larger, then residents should be attracted to those places.

4 Data

This work uses information on the 219 cities in California that had a population of 25,000 people or over in 1990 (see the list of cities in the Appendix). Socio-economic characteristics of each city are obtained from the US Census Bureau's County and City Data Book 1994, while the data for the adoption of UGC in the cities are from the 1989 survey by Glickfeld and Levine (1992). This survey, answered by local public officials, consisted of a questionnaire about which types of land use restrictions were in place. In accordance with the purpose of this work, only restrictions to residential construction were considered. Table 1 shows the nature of these land use regulations.

As a measure of the intensity of UGC (denoted **ugc**), the number of different types of land use regulations adopted by the city is used (a list of types and frequency of adoption is shown in Table 1). This index can vary from 0 to 9, although it only reaches a maximum of 6 in the sample. On average, each city adopted 1.78 different types of regulations, and 110 cities (among the 144 ones in the sample that had the survey answered) had adopted at least one type.

Table 1: Growth-control measures and percentage of jurisdiction adopting

Growth-control measure	Percentage adopting[a]
Growth management plan	18.75
Population growth limits	13.19
Restriction on the number of residential building permits	13.89
Housing infrastructure requirements for new residential development	32.64
Reduction of permitted residential density	37.50
Requirement of voters approval to increase residential density	6.94
Requirement of super-majority council vote to increase residential density	3.47
Rezoned residential land to less intense use	6.94
Urban limit line beyond which development is not permitted	19.44

[a] *Percentage refers to cities in the sample that had information on UGC (144 cities).*

Table 2: Percentiles of **wkoutpc**

Percentiles	0.01	0.05	0.10	0.25	0.50	0.75	0.90	0.95	0.99
wkoutpc	19.60	31.20	38.60	58.70	73.20	82.90	86.90	88.80	91.20

For the intensity of IC, the estimations uses the percentage of workers who work outside the place of residence (denoted as **wkoutpc**). This proportion varies from 18.9% to 92.7% in the sample. The average was 68.72%. Table 2 exhibits the main percentiles.

Note that both IC and UGC imply interactions between cities (respectively, the flow of workers between cities and the diversion of population to other cities). Thus, there could be a problem of missing information, since the estimation considers less than half of California's cities. Fortunately, the 219 cities included in the sample are the ones with the largest populations (25,000 people or over), accounting for 72% of the state population at the time (1990). However, only 144 of the 219 cities in the sample had the growth-control survey answered. A problem arises if the nonrespondent cities had significant number of growth-control measures in place. This work assumes that the constructed index of UGC in neighboring cities is highly correlated to the true index.

Table 3 defines the variables used in the empirical work, while Table 4 presents descriptive statistics (i.e., number of observations, mean, standard deviation, and minimum and maximum values) of those variables. Table 4 also includes the statistics for the variables **white** (the proportion of white people in the population) and **age25-34** (the proportion of people between 25 and 35 years old). These two groups of people are excluded from the

Table 3: Description of Variables

Variable	Definition[a]
wkoutpc	workers 16 years and old, percent working outside place of residence
black	population by race, percent black
asian	population by race, percent Asian
hispanic	population by origin, percent Hispanic
age-17	population by age, percent under 17 years
age18-24	population by age, percent between 18 and 24 years
age35-44	population by age, percent between 35 and 44 years
age45-64	population by age, percent between 45 and 64 years
age65-	population by age, percent 65 years and over
female	civilian labor force, percent female
ba	persons 25 years and over, percent with bachelor's degree
married	persons 18 years and over, percent married
homeowner	housing units, percent owner-occupied
area	land area in square miles
unemploym	labor force, percent unemployed
n-govmnt	city government employment per 10,000 population, 1991
jobs	number of employees in the manufacture, trade, taxable services, and city government sector in the city $\times 1,000$
jobs-nb	number of employees in manufacture, trade, taxable services, and city government sector in neighboring cities[b] $\times 1,000$
ugc	index of intensity of urban growth controls, 1989
wd-ugc	weighted sum of urban growth controls in neighboring cities[b], 1989 (weight = inverse of the distance to the neighboring city[b])
w1-ugc	weighted sum of urban growth controls in neighboring cities[b], 1989 (weight = 1 for all neighboring cities[b])

[a] *Observations are for 1990, unless other year is specified.*
[b] *Cities are defined as neighbors if their geographical centers are located less than 50 miles away from each other.*

estimation, working as the benchmark[14].

5 Estimation results

The results of the estimation of model (11) are shown in Table 5. Notice that robust White standard errors were used to correct for heteroscedasticity in the error distribution.

First, notice that the inclusion of a growth-control variable results in a greater adjusted R^2, indicating an increased explanatory power of the empirical model. The estimates of the coefficients for **wd-ugc** in model A and **w1-ugc** in model B are positive and significantly

[14] The benchmark for race is actually all the race types not included in the estimation (**white** being by far the largest group). Notice that even though the variable **hispanic** does not represent a race type in the census (but a cultural background), it is included in the estimation as a proxy for the race type generally associated with the term "Hispanic".

Table 4: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
wkoutpc	219	68.72	18.11	18.9	92.7
white	219	71.98	17.07	10.6	97.1
black	219	5.58	7.98	0.1	54.9
hispanic	219	24.26	18.67	3.0	93.1
asian	219	9.76	8.87	0.8	57.5
age0-17	219	26.01	5.72	7.1	40.2
age18-24	219	11.41	3.90	5.3	33.5
age25-34	219	19.17	3.03	9.5	29.7
age35-44	219	15.70	2.40	7.8	22.8
age45-64	219	17.21	3.68	9.2	32.7
age65-	219	10.50	4.92	3.8	42.1
female	219	44.35	2.47	36.4	54.6
ba	219	23.67	12.92	1.6	65.2
married	219	52.81	8.14	25.0	71.8
homeowner	219	57.29	13.26	22.3	90.9
area	219	23.51	41.95	1.2	469.3
unemploym	219	6.22	2.70	2.3	17.0
n-govnmt	203	69.38	41.88	5.0	358.0
jobs	158	35.24	91.79	2.5	1057.2
jobs-nb[a]	219	1621.18	1105.78	0	2985.6
ugc	144	1.53	1.52	0	6.0
wd-ugc[b]	219	2.66	1.95	0	19.2
w1-ugc[b]	219	47.15	22.65	0	84.0

[a]***jobs-nb*** *is calculated using the 158 observations for* ***jobs***
[b]***wd-ugc*** *and* ***w1-ugc*** *are calculated using the 144 observations for* ***ugc***

different from zero, evidencing that controls increase commuting of workers between cities, in accordance with the theory. However, since the growth-control variable used in the estimation is an ordinal measure of the intensity of controls, the sizes of the coefficients have no relevant interpretation. This study focuses only on the qualitative effect of controls on IC.[15]

Turning to the effects of socio-economic variables, first recall that the reference group for race used in the estimation is the white population, while the reference group for age is the 25 to 34 years old population. With this consideration in mind, the results of the estimation indicate that most of the variables considered are statistically significant at 0.01 probability level, with the estimated values in Models A being very similar to the values in Model B. Moreover, the signs of the coefficients are the expected ones, i.e., commuting

[15]A rough calculation may give an idea of the potential impact of UGC: considering that the average proportion of intercity commuters in the sample is 69%, using the mean values of **w1-ugc** and **wd-ugc** in the sample, the estimated coefficients imply that 16 of the 69% are due to UGC.

Table 5: Results

Dependent variable: wkoutpc
Ordinary Least Square (OLS) Estimation

Explanatory Variable	No UGC Coefficient	No UGC Robust Std. Err.	Model A: $W_{h,i} = 1/d_{i,h}$ Coefficient	Model A: Robust Std. Err.	Model B: $W_{h,i} = 1$ Coefficient	Model B: Robust Std. Err.
constant	160.643***	(33.380)	113.561***	(28.646)	117.879***	(36.654)
black	0.660***	(0.118)	0.580***	(0.102)	0.561***	(0.114)
hispanic	0.440***	(0.084)	0.302***	(0.088)	0.422***	(0.085)
asian	0.141**	(0.069)	-0.007	(0.073)	0.082	(0.070)
age0-17	-3.193***	(0.602)	-2.897***	(0.490)	-2.653***	(0.634)
age18-24	-1.388***	(0.453)	-0.951**	(0.416)	-0.885*	(0.474)
age35-44	-0.926	(0.767)	-0.255	(0.667)	-0.418	(0.720)
age45-64	-1.060**	(0.463)	-1.052***	(0.382)	-0.372	(0.519)
age65-	-1.705***	(0.417)	-1.537***	(0.349)	-1.390***	(0.413)
female	-0.709	(0.543)	-0.358	(0.416)	-0.517	(0.533)
ba	0.096	(0.122)	-0.013	(0.113)	0.006	(0.118)
married	1.186***	(0.240)	1.180***	(0.214)	0.989***	(0.258)
homeowner	0.083	(0.101)	0.166*	(0.088)	0.063	(0.102)
area	-0.143***	(0.029)	-0.139***	(0.025)	-0.141***	(0.027)
unemploym	0.445	(0.798)	0.726	(0.711)	0.470	(0.773)
n-govnmt	-0.139***	(0.027)	-0.108***	(0.023)	-0.132***	(0.029)
jobs	0.023	(0.019)	0.022	(0.018)	0.017	(0.020)
jobs-nb	0.007***	(0.001)	0.001	(0.001)	0.001	(0.002)
wd-ugc			6.101***	(0.851)		
w1-ugc					0.334***	(0.088)
Number of obs.	158		158		158	
Adjusted R^2	0.789		0.839		0.811	
F(18,139)	47.6[b]***		59.59***		48.81***	

[a] *Robust S.E. refers to robust White standard errors. ***, **, and * indicate significance levels at 0.01, 0.05, and 0.10 respectively.*
[b] F(17,140)

of residents to outside places is positively affected by concentration of black, Hispanic, and married people, but negatively affected by the concentration of young and old people, and by the availability of government employment. In model A, home ownership is also statistically significant at 0.10 probability level, being positively related to the proportion of intercity commuters. However, the other variables (the proportions of Asians and of college graduates in the population, the proportion of females in the labor force, the unemployment rate, the number of jobs in the city, and the number of jobs in neighboring cities) are not statistically significant.[16] These other variables were kept in the final estimation for the intuitive plausi-

[16] The number of jobs in neighboring cities is significant when no growth-control variable is included, perhaps indicating that the intensity of UGC in neighboring cities is correlated to the size of their economies.

bility, but their exclusion would not affect the main results (i.e., the size of the coefficients and the statistical significance of **wd-ugc** or **w1-ugc** would not change considerably).

6 Concluding remarks

This paper examines the relationship between intercity commuting by workers and the adoption of growth-control measures by jurisdictions. The theoretical hypothesis suggests a positive relationship because controls create a wage advantage for the controlled city (due to the diversion of labor supply to other places). This advantage, along with higher housing rents there, induces people to work in the controlled city, but to reside in uncontrolled neighboring places.

The results of the estimation, which takes into consideration several other socio-economic city characteristics, indicate that the intensity of intercity commuting (measured by the proportion of the labor force working outside the place of residence) is positively affected by the existence of growth controls in neighboring cities, as predicted by the theory.

For future research consideration, notice that the use of city characteristics (which are averages of individuals characteristics) might not be the ideal approach because IC is an individual decision, depending mostly on individual characteristics. Along with the possibility that a greater number of cities can be included, the use of individual level data could give better estimates of the effects of UGC on jobs-housing mismatches.

Appendix

List of cities included in the sample

There were 219 cities in the US Census Bureau's County and City Data Book 1994 with data for the socio-economic characteristics used in this work. These are the cities with 25,000 people or over in 1990. For some of the cities in the sample, there was no information on the adoption of UGC (such cities are indicated with "*").

Alameda city*, Alhambra city, Anaheim city, Antioch city, Apple Valley town*, Arcadia city, Azusa city, Bakersfield city, Baldwin Park city, Bell city, Bell Gardens city, Bellflower city*, Berkeley city*, Beverly Hills city*, Brea city, Buena Park city, Burbank city, Burlingame city, Camarillo city, Campbell city, Carlsbad city, Carson city*, Cathedral City city*, Ceres city*, Cerritos city*, Chico city, Chino city, Chula Vista city, Claremont city*, Clovis city*, Colton city, Compton city*, Concord city, Corona city, Coronado city*, Costa Mesa city, Covina city, Culver City city, Cupertino city, Cypress city, Daly City city*, Dana Point city*, Danville city*, Davis city, Diamond Bar city*, Downey city, El Cajon city, El Centro city, El Monte city*, Encinitas city*, Escondido city, Eureka city, Fairfield city, Folsom city*, Fontana city, Foster City city*, Fountain Valley city, Fremont city, Fresno city, Fullerton city*, Garden Grove city, Gardena city*, Gilroy city, Glendale city, Glendora city, Hanford city, Hawthorne city, Hayward city, Hemet city, Hesperia city*, Highland city*, Huntington Beach city, Huntington Park city, Imperial Beach city*, Indio city*, Inglewood city, Irvine city, La Habra city, La Mesa city*, La Mirada city, La Puente city*, La Verne city, Laguna Niguel city*, Lakewood city, Lancaster city*, Lawndale city*, Livermore city, Lodi city, Lompoc city*, Long Beach city, Los Altos city*, Los Angeles city, Los Gatos town, Lynwood city, Madera city*, Manhattan Beach city*, Manteca city, Marina city*, Martinez city*, Maywood city*, Menlo Park city*, Merced city, Milpitas city, Mission Viejo city*, Modesto city, Monrovia city, Montclair city, Montebello city, Monterey city*, Monterey Park city, Moorpark city*, Moreno Valley city*, Mountain View city, Napa city, National City city, Newark city, Newport Beach city, Norwalk city, Novato city, Oakland city, Oceanside city, Ontario city, Orange city, Oxnard city, Pacifica city*, Palm Springs city, Palmdale city*, Palo Alto city, Paradise town*, Paramount city, Pasadena city, Petaluma city, Pico Rivera city, Pittsburg city*, Placentia city, Pleasant Hill city, Pleasanton city, Pomona city, Porterville city, Poway city*, Rancho Cucamonga city, Rancho Palos Verdes city*, Redding city, Redlands city, Redondo Beach city*, Redwood City city, Rialto city, Richmond city, Ridgecrest city*, Riverside city, Rohnert Park city*, Rosemead city, Roseville city, Sacramento city, Salinas city, San Bernardino city, San Bruno city*, San Buenaventura (Ventura) city*, San Carlos city, San Clemente city*, San Diego city, San Dimas city, San Francisco city*, San Gabriel city*, San Jose city, San Juan Capistrano city*, San Leandro city*, San Luis Obispo city, San Marcos city, San Mateo city, San Pablo city*, San Rafael city, San Ramon city*, Santa Ana city, Santa Barbara city, Santa Clara city, Santa Clarita city*, Santa Cruz city, Santa Maria city, Santa Monica city, Santa Paula city*, Santa Rosa city, Santee city*, Saratoga city*, Seal Beach city*, Seaside city*, Simi Valley city, South Gate city, South San Francisco city, Stanton city, Stockton city, Sunnyvale city, Temecula city*, Temple City city*, Thousand Oaks city*, Torrance city, Tracy city, Tulare city, Turlock city, Tustin city, Union City city, Upland city, Vacaville city, Vallejo city, Victorville city, Visalia city, Vista city, Walnut city, Walnut Creek city, Watsonville city, West Covina city, West Hollywood city*, West Sacramento city*, Westminster city, Whittier city, Woodland city, Yorba Linda city*, Yuba City city, and Yucaipa city*.

References

J.K. Brueckner, Modeling urban growth controls, in: A. Panagariya, P. Portney, R.M. Schwab (Eds.), Environmental and Public Economics: Essays in Honor of Wallace E. Oates, Edward Elgar Publishers, 1999, pp. 151-168.

US Bureau of the Census, County and City Data Book. Washington, DC: US Department of Commerce, 1994.

R. Cervero, Jobs-housing balancing and regional mobility, Journal of the American Planning Association 55 (1989) 136-150.

D.M. Cutler, E.L. Glaeser, J.L. Vigdor, The rise and decline of the American ghetto, Journal of Political Economy 107 (1999) 455-506.

W.A. Fischel, Do Growth Controls Matter? A Review of Empirical Evidences on the Effectiveness and Efficiency of Local Government Land Use Regulation, Lincoln Institute of Land Policy, Cambridge, MA, 1990.

M. Glickfeld, N. Levine, Regional Growth ... Local Reaction, Cambridge. MA: Lincoln Institute of Land Policy, 1992.

A. Gonzalez, Mexican enclaves and the price of culture, Journal of Urban Economics 43 (1998) 273-91.

B.S. Lee, J.F. McDonald, Determinants of commuting time and distance for Seoul residents: the impact of family status on the commuting of women, Urban Studies, 40 (2003) 1283-1302.

N. Levine, The effects of local growth controls on regional housing production and population redistribution in California, Urban Studies 36 (1999) 2047-2068.

L.M. Ogura, Urban growth controls and intercity commuting, Journal of Urban Economics 57 (2005) 371-390.

Figure 1: Effects of controls on rents

Figure 2: Effects of controls on labor market