Strategic Interaction and Spatial Multiplier Effects in Local Growth Control Policies: The California Housing Market

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Abstract. Since the 1970s, growth controls spread across many metropolitan regions in the United States. Several studies address the effects of local growth controls on housing markets, particularly its price effect, which is induced by rising construction cost, constrained housing supply, improved amenities, and market reorientation of homebuilders. However, only few studies explicitly address inter-jurisdictional spatial spillovers and strategic interaction of policy-makers of different jurisdictions in the design of growth control policies. This study focuses on two housing market outcomes, supply of new housing and market orientation, and utilizes a spatial econometric framework to systematically investigate local and global spatial spillovers giving rise to spatial multiplier effects. Preliminary results suggest that market orientation of new home building is primarily influenced by population growth and building permit caps, with positive spillovers at the local level only. For the supply of new housing, however, the models seem to suggest positive global spillover effects. However, there is additional indication of a potential relevance of including spatial heterogeneity in the model specification. Specifically, a north-south disparity or a coastal-inland disparity may have non-negligible impacts with concurrent implications for policy-making.

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1. INTRODUCTION

Since the 1970s, growth control and growth management measures have become quite popular in the planning efforts of local jurisdictions in the United States. Growth control measures limit population growth or housing construction, usually in the form of population growth caps, residential building permit caps or even moratoria, and restrictive zoning, such as large minimum lot zoning. Growth management measures are an alternative to *ad hoc* strategies of dealing with urban growth and refer to measures that respond to anticipated growth by minimizing growth-induced costs yet still accommodating growth. These measures typically include urban growth boundaries, procedural requirements for development, and requirements for the provision of infrastructure. As Landis (1992) points out, growth control and growth management measures are often intermingled in the real world. Thus, to simplify the terminology, we will use the term 'growth control' to refer to both types of measures.

The adoption of growth controls has been quite substantial, in particular in the State of California. As documented by Levin (1999), it was during the 1980s that the enactment of local growth controls swept across the state. This can be attributed to a variety of factors, foremost to accelerated population growth, rapid suburbanization and urban sprawl, increasing concern about urban growth-induced costs, and the constraints of local fiscal resources brought about by Proposition 13[1] (Glickfeld and Levine 1992; Pincetl 1994; Levine 1999, Byun et al. 2005). Moreover, the diffusion of growth controls was also propelled by strategic interaction among local jurisdictions (Brueckner 1998), a process that is certainly facilitated by political fragmentation so typical of metropolitan areas in California (Glickfeld and Levine 1992).

The increased prevalence of growth controls has spurred a flood of studies that address the impact of growth controls on local housing markets, including the social issues such as exclusion of low-income populations (Schwartz et al. 1981, Levine 1999, Pendall 2000). A primary focus in these studies are price effects of growth controls (e.g., Fischel 1990, Singell and Lillydahl 1990, Janczyk and Constance 1980, Pollakowski and Wachter 1990, Landis 1986, Schwartz et al. 1981, Katz and Rosen 1987, Phillips and Goodstein 2000). Empirical estimates of the magnitude of price effects do, however, paint a mixed picture. For example, Katz and Rosen (1987) estimate that housing in growth-controlled communities is between 17 and 38 percent higher than in non-growth controlled communities. In contrast, in their analysis of urban growth regulations, Phillips and Goodstein (2000) find that urban growth boundaries have a relatively small price effect.

[1] Proposition 13, passed in 1978, is a California initiative for lessening property tax burden. The initiative brought the assessed value of property back to the level of 1975, limited the annual increase in the assessed value to 2%, and did not permit annual property tax rate of over 1% without a two-thirds majority for the tax rate in California state legislature (Fulton 1993).

The ambiguous empirical results are not surprising given that housing price changes may be viewed as aggregate outcomes of a complex web of growth-control induced effects on a variety of factors. These factors include the cost of land, regulatory development delays, planning costs, quantity of new housing supplied, amenities, barriers to homebuilders' entry into the housing market, and homebuilders' market re-orientations towards upscale market segments. Moreover, different types of growth controls may influence these components differently. Many studies, therefore, focus on particular types of growth controls and / or particular components of the complex web of causative factors. For example, Schwartz et al. (1981) conclude that growth controls lead to higher housing quality and thus price increases of new housing. Landis (1986) suggests that price effects are indirect, i.e., that restrictions placed on developable land supply foster a monopoly of few homebuilders and thus exclusive power over prices and quality of new housing. Mayer and Somerville (2000) argue that land use regulations, especially those that lengthen the development process, reduce new construction and price elasticities. Levine (1999) finds that growth control policies that restrict developable land and reduce residential densities, lower the supply of new housing.

The literature also pays attention to the timing of the impact of growth controls on housing market outcomes (Janczyk and Constance 1980, Thorson 1997, Mayer and Somerville 2000). For example, Janczyk and Constance (1980) distinguish between anticipatory impacts and direct impacts once the policy is in effect, and suggest that supply expansions during the anticipatory stage may be responsible for lagged direct effects on the supply of new housing.

In addition to temporal aspects, the literature is also cognizant of potential spatial effects. There seems to be a universal understanding that the factors coming into play when analyzing the impacts of growth controls on housing market outcomes, have explicit spatial components, and the literature repeatedly alludes to the importance of potential spatial dependencies, in particular in the form of spatial spillovers. For example, Janczyk and Constance (1980) suggest that – in anticipation of pending growth control enactments – supply and demand in *adjacent* jurisdictions shift outward. Similarly, Pollakowski and Wachter (1990) find that housing prices are positively related to zoning restrictiveness in adjacent areas, and conclude that growth controls induce a spatial spillover of demand. Elliot (1981) concludes that "local consequences of growth controls do not adequately reflect the regional consequences; the price effects do not solely occur within a single jurisdiction but rather occur among many jurisdictions; therefore price effects should be considered within the context of the region as a whole" (p. 129). Thorson (1994) and Levine (1999) suggest that growth controls induce shifts in new housing construction to adjacent areas with fewer controls.

So far the literature has not advanced beyond an acknowledgement of the existence of spatial effects (Katz and Rosen 1987, Schwartz et al. 1981) and, at best, accounts for spatial effects rather rudimentarily, for example, by including a variable that controls for growth controls in adjacent areas (Pollakowski and Wachter 1990). However, a rigorous treatment of spatial dependencies inherent in the effects of growth controls on housing markets is still lacking.

In this paper, we therefore analyze the effects of local growth controls on local housing market outcomes in a spatial econometric setting that allows for investigating spatial spillovers and interactions among neighboring jurisdictions. Specifically, we adopt the framework put forward by Anselin (2003) that distinguishes between local and global spatial spillovers. Local spillovers take effect within a spatially limited range of neighboring localities. In contrast, global spillovers extend through the entire system of spatially dependent localities. In the analysis of spatial spillovers, we distinguish between five different types of growth control, and focus specifically on two types of housing market outcomes: the magnitude of new housing supply, and homebuilders' market reorientation toward upscale segments of local housing markets. We use data of the 1988 comprehensive survey of local growth controls in California, as well as local jurisdictions' residential building permit issuance data, and general data on population and housing.

Following this introduction, we first review the mechanisms of market re-orientation and constraints of new housing supply in response to growth controls, and conceptually distinguish different types of spatial spillovers that come into play when analyzing these housing market outcomes of growth controls. We then describe the data and present an exploratory spatial analysis of growth controls, new housing supply, and market orientation towards upscale housing in the State of California. Next, we discuss the results of the spatial econometric models of new housing supply and market orientation. The final section concludes by presenting summaries of the results, and suggesting further research.

2.MARKET REORIENTATION AND NEW HOUSING SUPPLY CONSTRAINTS

Local growth controls raise housing construction costs and reduce profitability of homebuilding. Homebuilders may respond by reorienting their target markets towards housing for high-income homebuyers[2] (see Dowall 1979, 1984; Schwartz et al. 1984; Landis 1986; Nelson et al. 2002; Pendall 2000). In fact, the switch to upscale and larger-size housing can be interpreted as a strategy aimed at counterbalancing the reduced profitability resulting from local growth controls (Dowall 1979, 1984; Landis 1986).

The market reorientation strategy can be performed more effectively when homebuilders secure monopolistic positions in local housing markets. Several studies suggest that local growth controls can confer the monopolistic power on homebuilders, particularly large-size homebuilding firms (Landis 1986; Dowall 1984; Rosen and Katz 1981; Frieden 1983; Somerville 1999). The controls force incumbent homebuilders out of local housing markets by increasing construction costs, and these homebuilders then move to jurisdictions without growth controls (Levine 1999). In addition, growth controls function as barriers to market entry of new homebuilders (Dowall 1979, 1984; Landis 1986). In this situation, remaining homebuilders will likely have the power to control price as well as quality of new housing. Stated otherwise, with monopolistic power, the remaining (particularly, large-size) homebuilders can extract excess profits, and can shift their targets to the upscale market segments without intense competition. The market reorientation mechanism operating in a growth-controlled local housing market is summarized in Figure 1.

< Figure 1 about here >

As an alternative response to growth control-induced reduction in profitability of homebuilding, homebuilders may reduce or even abandon housing construction in growth-controlled jurisdictions, and move to localities without growth controls (see Rosen and Katz

[2] Note that the upscale trend is also a consequence of local growth controls that directly influence the quality of new housing (Landis 1986).

1981; Dowall 1984; Landis 1986; Lillydahl and Singell 1987; Singell and Lillydahl 1990; Skidmore and Peddle 1998; Levine 1999; Nelson et al. 2002). Local growth controls will thus not only induce a shift towards upscale market segments, but also constrain the amount of homebuilding (Dowall 1984; Nelson et al. 2002; Landis 1986; Lillydahl and Singell 1987; Singell and Lillydahl 1990; Skidmore and Peddle 1998; Levine 1999). As Janczyk and Constance (1980) argue, “[a] common feature of local growth control measures is restriction of housing supply” (p. 11). Thus, in localities imposing growth controls, the number of newly constructed housing units is likely to decrease. This sets in motion spillovers as the reduction in housing construction shifts housing demand from growth-controlled localities to neighboring localities with no or fewer controls. Although the existing vacant housing stock of nearby localities can absorb initial spillovers, this reserve will soon disappear, creating demand for new housing. This condition may lead homebuilders in growth-controlled jurisdictions to enter the proximate non-growth-controlled jurisdictions (Levine 1999). As a result, the neighboring localities will likely experience an increase in housing construction. The controls discourage many incumbent homebuilders from constructing housing by increasing costs and reducing profitability of homebuilding. As a result, supply of new housing is reduced and housing prices are inflated.

3. SPATIAL EFFECTS

The above discussion suggests that a comprehensive evaluation of growth controls and their effect on housing market outcomes needs to take place within the system of spatially dependent localities rather than focus on localities as independent entities. We investigate three types of spatial dependencies to capture the hypothesized spillover effects of growth control policies. The first type, already identified in the literature, is the effect of growth controls not only on housing market outcomes in the own community but also for the immediate neighbors. From a spatial econometric perspective, these effects can easily be accommodated in a spatial cross-regressive model (Florax and Folmer 1992, Anselin 2003). It takes on the form:

$$\mathbf{y} = \mathbf{G}\boldsymbol{\beta} + \mathbf{W}\,\mathbf{G}\boldsymbol{\gamma} + \mathbf{W}\,\mathbf{X}\,\boldsymbol{\xi} + \mathbf{X}\,\boldsymbol{\delta} + \boldsymbol{\varepsilon}$$

where **y** is the $n \times 1$ vector including the observations on the housing market variable (supply of new housing, or market orientation of homebuilding), **G** denotes the matrix of growth policy variables, **W** is a $n \times n$ matrix describing adjacency linkages[3] between localities, **X** is a $n \times k$ matrix of control variables, $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, $\boldsymbol{\zeta}$, and $\boldsymbol{\delta}$ are parameter vectors, and $\boldsymbol{\varepsilon}$ is the i.i.d. N(0,σ^2**I**) error term. Note that **WG** is a matrix of the "average growth controls" in neighboring localities. The interpretation of the parameters in a spatial cross-regressive model is straightforward. For example, if **y** denotes the supply of new housing then – following the discussion above – we expect a β parameter to be negative if the associated growth control policy reduces the supply of new housing in the own community, and the γ parameter to be positive if the policy shifts new housing supply to neighboring areas.

This cross-regressive model captures local spillovers. That is, following Anselin (2003) such a model is appropriate if the spatial range of the growth control policy only extends into the immediate localities. If however, it is assumed that the spatial spillovers are global, i.e.,

[3] A frequently used weight matrix, which is also adopted in this paper, is the row-standardized contiguity matrix where $w_{ij} = 1/n_i$ (n_i is the number of neighbors of i) if localities i and j are neighbors, and $w_{ij} = 0$ otherwise. The diagonal elements of weight matrices are set equal to zero. It should be noted that spatial associations can also be defined in a variety alternative ways, e.g., in terms of distances. The diagonal elements of weight matrices are set equal to zero.

spreading through the entire system, then different models need to be specified. The most commonly known model is the spatial lag model (Anselin 1988, 2003; Florax and Nijkamp 2004) which takes on the form:

$$\mathbf{y} = \rho\,\mathbf{WY} + \mathbf{G}\boldsymbol{\beta} + \mathbf{X}\,\boldsymbol{\delta} + \boldsymbol{\varepsilon}$$

where ρ denotes the spatial auto-regressive parameter. The spatial dependence captured in the spatial lag model is often referred to as substantive spatial dependence, in which the dependent variable Y affects, and is affected by the realizations of Y in neighboring areas. This second type of spatial dependency results if housing market outcomes in one region are functionally dependent on those of neighboring regions. This dependency may, for example, be due to neighboring housing markets being substitutes, and thus be equally profitable for homebuilders, or development in one locality spurring spillover of development into adjacent housing markets.

The reduced form of the model does, however, suggest an alternative interpretation that speaks directly to spillover effects (Anselin 2003):

$$\mathbf{y} = (\mathbf{I}\text{-}\rho\,\mathbf{W})^{-1}\,(\mathbf{G}\boldsymbol{\beta} + \mathbf{X}\,\boldsymbol{\delta} + \boldsymbol{\varepsilon})$$

or

$$\mathbf{y} = (\mathbf{I}\text{-}\rho\,\mathbf{W})^{-1}\,\mathbf{G}\boldsymbol{\beta} + (\mathbf{I}\text{-}\rho\,\mathbf{W})^{-1}\,\mathbf{X}\,\boldsymbol{\delta} + (\mathbf{I}\text{-}\rho\,\mathbf{W})^{-1}\,\boldsymbol{\varepsilon}$$

The matrix $(\mathbf{I}\text{-}\rho\,\mathbf{W})^{-1}$ ensures that spatial externalities travel through the entire system and thus are not constrained to the immediate neighbors. Thus, the spatial lag model responds to global spillovers (Anselin 2003). But, the model also suggests that spatial externalities are present in all modeled effects (i.e., not just **G** but also the control variables **X**) and in the errors.[4] In particular, spatially correlated errors will arise due to omitted spatially correlated variables.

[4] Note that removing the constraints of identical autoregressive parameters and identical weight matrices is a straightforward generalization.

A third type of model, a spatial error model, is appropriate if we assume that global spatial effects are solely due to the unmodeled effects (error terms). The spatial dependency captured in the spatial error model is often referred to as "nuisance dependence" (Anselin and Rey, 1991) because it is caused either by omitted spatially correlated variables or by the spatial extent of, in the context of this paper, the housing market not coinciding with the actual behavioral unit of housing market actors. From an econometric perspective, this type of spatial dependence is reflected in spatially autocorrelated error terms, and leads to the spatial error model of the form:

$$\mathbf{Y} = \mathbf{G\beta} + \mathbf{X\,\delta} + \boldsymbol{\varepsilon}, \text{ where } \boldsymbol{\varepsilon} = \lambda\mathbf{W}\boldsymbol{\varepsilon} + \boldsymbol{\upsilon}$$

or

$$\mathbf{Y} = \mathbf{G\beta} + \mathbf{X\,\delta} + (\mathbf{I} - \lambda\,\mathbf{W})^{-1}\,\boldsymbol{\upsilon}$$

where λ is the spatial error coefficient, and $\boldsymbol{\upsilon} \sim N(0,\sigma^2\mathbf{I})$ are independent error terms. Multiplying[5] by $(\mathbf{I} - \lambda\,\mathbf{W})$ shows that the spatial error model includes both the "spatially lagged dependent variable and the spatially lagged exogenous variables" (Anselin 2003):

$$\mathbf{Y} = \lambda\,\mathbf{W}\,\mathbf{Y} + (\mathbf{G\beta} + \mathbf{X\,\delta}) - \lambda\,(\mathbf{G\beta} + \mathbf{X\,\delta}) + \boldsymbol{\upsilon}$$

The spatial econometrics literature has developed a series of tests to investigate the presence of spatial dependencies, as well as tests to identify the proper model (for an overview see Florax and Nijkamp 2004). Both the spatial lag model and the spatial error model need to be solved via maximum likelihood estimators. Ignoring the spatial dependencies captured in these models leads to misspecifications and invalid inferences (Anselin 1988). In particular, OLS

[5] Note that this transformation introduces nonlinear constraints on the parameters. To ensure equivalence, of the two specifications are only the same if the estimated lambda and the estimated beta equal product of the parameter estimates (common factor hypothesis; see Anselin (1988)).

estimators are biased and inconsistent if ignoring the spatially lagged dependent variable (Anselin 1988). Ignoring the spatially correlated error leads to inefficient estimators and thus affects the standard errors of the parameter estimators.

4. EMPIRICAL ANALYSIS

4.1 Study Area and Data

The empirical analysis targets local jurisdictions in the State of California. California is a pioneer of growth control and management measures (Fulton 1993). Since the 1970s, a rapidly increasing number of jurisdictions has adopted growth controls across the state (Glickfeld and Levine 1992). In California, attempts to establish statewide or region-wide growth control and management for overcoming the lack of regional coordination continually failed (Pincetl 1994). In fact, political fragmentation – a critical condition for the enactment and diffusion of local growth controls – is a dominant characteristic throughout California (Glickfeld and Levine 1992).

In the empirical analysis, we utilize the unique data set compiled by Glickfeld and Levine (1992). They conducted a comprehensive survey of local growth controls within California in 1988-1989.[6] The survey data provide information on types and numbers of growth controls implemented in each locality as of 1988. From this information, we use the growth controls applied to residential development as summarized in Table 1: population growth or housing permit caps; urban growth boundaries; adequate public facility ordinances; restrictive residential zoning (e.g., large minimum-lot size requirement, downzoning); and restrictive zoning approvals

[6] In total, 443 of 508 jurisdictions responded to the survey – all 58 counties and 385 out of 450 incorporated cities in California.

(e.g., requirement of council supermajority or voter approval for increase in residential density). Unfortunately, the data do not include information of the adoption year or on the annual status of each control in each locality.

<Table 1 about here>

The primary data on housing market outcomes are taken from the "Annual New Privately-owned Residential Building Permits" data collected and reported by the U.S. Census Bureau. For every year, this data set provides the number of issued residential building permits for each local jurisdiction. The data exclude the building permits issued for the conversions of and alterations to existing residential buildings, and such buildings as mobile homes, hotels, motels, nursing homes, and college dormitories. A three-year average for 1988-1990 of the building permit data are used to operationalize new housing supply. Clearly, such building permit data do not show actual housing construction. However, considering that the data of housing construction are not available on an annual basis, the building permit data has repeatedly been used as a proxy for new construction (see Thorson 1997; Mayer and Somerville 2000).

The "Annual New Privately-owned Residential Building Permits" data also provide information on the total estimated construction costs for the newly permitted residential buildings. The estimated construction costs exclude labor and land costs, and cover only material costs.[7] More luxurious homes will have higher construction material costs. Thus higher construction material costs will signal an "upmarket trend" (Landis 1986, p. 11). We therefore use the three-year average perdwelling construction material costs as proxy for the market orientation of homebuilders.

[7] The Manufacturing and Construction Division of the U.S. Bureau of Census confirmed this for our work.

These data are merged with population and housing data from the 1980 Census of Housing, and the 1990 Census of Population and Housing. In addition, intercensal population estimates for California counties and cities are taken from the Department of Finance of the State of California (*http://www.dof.ca.gov*). The data merging provides complete information for 420 of the 508 jurisdictions in California (see Figure 2).

4.2 Exploratory Spatial Data Analysis

As of 1988, about 60 percent of the California jurisdiction had some form of growth control, many of them even having more than one growth control. In fact, the average number of (residential) growth control policies in Californian jurisdictions is 1.1. A small community to the southeast of San Francisco, San Juan Bautista, has enacted six growth control measures and constitutes the most highly growth controlled locality in California. As summarized in Table 1, the most pervasive measures are adequate public facility ordinances (30 percent) and restrictive zoning (29 percent). The least frequently enacted measures are restrictive zoning approvals (12 percent) and caps on population growth or housing permits (14 percent). The frequency of urban growth boundaries takes on a middle position, with 18 percent.

< Figure 2 about here>

Figure 2 and Table 2 show that communities with growth control policies are not randomly scattered across the state, but tend to cluster. For all growth policies – with the exception of localities with restrictive zoning approvals – Moran's *I* is significantly positive.[8] Moreover, for all policies, the percentage of communities with a growth policy that are

[8] Moran's *I* is a measure of global spatial autocorrelation. For random patterns, the expected value, E(*I*), equals $-1/(n-1)$. $I > -1/(n-1)$ signals positive spatial autocorrelation, i.e., similar values cluster together. For $I < -1/(n-1)$, dissimilar values are located in close proximity to each other. For a comprehensive overview of Moran's *I* (global and local) see Anselin (1995, 1996).

surrounded by other communities with the same growth policy, is substantially higher than the equivalent percentages for communities without the policies. That is, the dominant spatial pattern is one of clustering of communities without the growth policy, and the clustering of localities with the policy.

< Table 2 about here >

The clustering is particularly strong for the 58 communities with population growth or building permit caps. These communities are nearly exclusively located in the metropolitan areas along the coast. Thirty-five percent each are located in the Los Angeles and San Francisco CMSAs where they make up 14 percent and 21.5 percent of all communities, respectively. Communities with an urban growth boundary are also significantly clustered and seem to be predominantly a “northern phenomenon”. Whereas communities without urban growth boundaries are equally divided by the 36 degree latitude (which is located slightly south of Monterey), about three quarters of all communities with an urban growth boundary are located north of 36 degree latitude. In these northern portions of the state, communities with growth boundaries also extend into the more peripheral inland sections of California. Moreover, both metropolitan and non-metropolitan communities have about the same share of communities with urban growth boundaries. Jurisdictions with adequate public facility ordinances, and jurisdictions with restrictive zoning show about an equal amount of moderate spatial clustering. However, there are some differences at the local scale. Whereas adequate public facility ordinances are quite frequently found in the more peripheral inland areas, restrictive zoning policies are very much a “southern phenomenon”. In both the Los Angeles and San Diego metropolitan areas, the percentages of localities with restrictive zoning far exceed the state average of 28.6 percent.

The above discussion illuminates that the spatial distributions of growth controls are positively spatially autocorrelated, thereby reinforcing Brueckner's (1998) conclusion that growth policy decisions "are not taken in a vacuum" (p. 465). However, while Brueckner (1998) looks at the degree of growth control stringency by aggregating different types of controls, the discussion above suggests that a similar result can be derived for each type of growth control policy. But, it also suggests that there are non-negligible differences between the various types of growth controls.

Relating growth control policies, enacted in different types of localities, to housing market outcomes further illuminates that the spatial arrangement is of pivotal importance. The types of localities are defined as follows:

	None of the neighboring localities are growth-controlled	At least one neighboring locality is growth-controlled
Locality *without* growth control	Type 1	Type 2
Locality *with* growth control	Type 3	Type 4

The first type is included localities without growth policies and surrounded by localities that are also not growth controlled. These localities face unrestricted growth but are also not at risk of having to absorb demand shifts from the surrounding communities. Interestingly, new supply in these localities is far above the state average and – as indicated by the below average material costs for new construction – the new housing seems to be targeted to low-income market segments. Surprising are, however, the housing market outcomes in Type-2 and Type-3 localities. Growth in Type-2 localities is unrestricted, but they are surrounded by growth-controlled communities and thus could serve as an ideal recipient for spillover in their neighbors' homebuilding activity. These are communities that should have the most intense homebuilding activity. However, as shown in Table 3, they actually record the least. Their average material costs are about equal to the state-average. Growth in Type-3 localities is restricted and, since they are surrounded by communities with unrestricted growth, they should easily be able to shift homebuilding activities into the adjacent localities. But Type-3 localities are not distinguished by below average homebuilding activity. Interesting is also that homebuilders in these communities do not seem to participate in the hypothesized upscale market trend: in fact, the average material costs are well below the state average. Finally, Type-4 localities which are growth controlled and are surrounded by other growth-controlled localities show average, rather than below average, homebuilding activity. This may be interpreted as a result of homebuilders not being able to penetrate adjacent growth-controlled markets. Interestingly, however, homebuilding in these growth-controlled communities seems to be strongly directed towards the upscale market: average material costs are substantially above those in other types of localities.

< Table 3 about here >

The housing market outcomes, i.e., the supply of new housing and the market orientation, are also clustered. Figure 3 shows that below average new construction (permits) is more dominant in coastal areas. These are also the areas in which upscale building (above average material costs) is more prevalent. In fact, upscale market orientation is almost non-existent in the peripheral inland areas. The spatial dependence of both housing market variables is of course expected if they are influenced by the spatially correlated growth control policies. Yet, the strength of the spatial autocorrelation coefficients is an indication that growth-controlled induced spillovers may well extend beyond the immediate neighbors and operate throughout the entire system of Californian jurisdictions. As outlined in a previous section, if this is the case then a spatial cross-regressive model is not sufficient to capture the spillovers. The following section investigates this issue via a series of spatial econometric models.

<Figure 3 about here >

4.3 Spatial Econometric Spillover Models

We begin our investigation with models that do not consider spillover effect. That is, we specify a models of the housing market outcomes (new housing supply and market orientation, respectively) that include five dummy variables capturing the presence of growth control measures as defined in Table 1, and a set of control variables. The choice of additional exogenous variables is constrained by limited data availability as well as the attempt to avoid severe multicollinearity. For the new housing supply model of average annual new housing permits issued from 1988 to 1990, the control variables include STOCK (existing housing stock as of 1990[9]), POPG (annual population growth between 1985 and 1988), HPG (growth of single family housing prices between 1985 and 1988), and METRO (a dummy variable distinguishing metropolitan from non-metropolitan jurisdictions). The housing stock variable is a supply side control but also checks size effects. Population growth is a control for demand pressure, and housing price growth controls for housing market inflation. The metropolitan variable serves to check additional heterogeneity of the local housing markets by picking up differences between metropolitan and non-metropolitan housing markets. For the market orientation model of the per

[9] Data on existing housing in 1988 is not available.

dwelling construction material costs of new housing permits between 1988 and 1990, the control variables include the 1990 median household income[10] as a proxy for the demand of upscale housing and homebuilding profitability, the population growth variable, housing growth variable, and the metropolitan dummy. With the exception of the dummy variables, all variables enter the model in logarithmic form so as to reduce heteroskedasticity and allow easy interpretation in the form of elasticities. All models are estimated using SpaceStat software.

< Table 4 about here >

The results, presented in Table 4, are quite unexpected. While the control variables show the anticipated behavior, i.e., housing stock size and population growth are positively, and housing price growth is negatively related to the new supply, and *vice versa* to market orientation.[11]

In the model of market orientation, only one growth control measure shows the expected positive impact: ceteris paribus, caps on population growth / housing permit caps significantly and substantially increase the construction material costs of new housing by 10 percent. All other growth controls do not have an effect on market orientation. Remarkable is also the estimated nine percent[12] cost difference between non-metropolitan and metropolitan localities.

In the model of new housing supply, only one growth control variable shows the expected negative impact on the provision of new housing. Restrictive zoning significantly reduces the new supply: compared to jurisdictions without restrictive zoning, localities with a restrictive zoning policy experience a 44.5 percent reduction in newly issued permits. Adequate

[10] Income data for 1988 is not available.
[11] In fact, new housing supply and market orientation seem to be jointly determined. We are presently exploring the assessment of spillovers in a simultaneous equation set-up.
[12] Based on the formula exp(b-.5VAR(b))-1 (see Kennedy 1981).

public facility ordinances and restrictive zoning approvals have no effect on new housing supply. Caps and urban growth boundaries are even estimated to increase the supply, and the magnitudes are quite substantial with 43 and 41 percent, respectively.

The diagnostics for spatial dependence suggest, however, that the new housing supply model and – to a lesser extent – the market orientation may suffer from misspecifications. Moran's I for the error terms are significant in both models. Moreover, the (robust) Lagrange multiplier test for the error is highly significant for the new housing supply model, and marginally significant for the market orientation model, whereas in both cases the robust Lagrange multiplier for the spatial lag model is insignificant. Thus, the diagnostics point into the direction of a spatial error model as the proper specification, and implicitly to the existence of global spillover effects as discussed in Section 3. However, before presenting the results for global spillovers in the form of spatial error and spatial lag models, we will first investigate whether we can find evidence of local spillovers. Towards that end, we estimate spatial cross-regressive model for both housing market variables, where spatially lagged exogenous variables are included as well. The results are presented in Table 5.

The spatial cross-regressive market orientation model suggests that caps are associated with an upscale market trend. However, the estimated effect is smaller than in the aspatial model, amounting to only 7.7 percent. The deficit impact is compensated by the spillover effect from neighboring areas. That is, the model suggests very strong positive spillovers of the effect of growth caps into neighboring localities. Interestingly, none of the other growth control policies or their spatial lags have a significant impact on market orientation. The diagnostics for spatial dependence indicate that there is no significant spatial autocorrelation left in the residuals. Thus, the growth-control-induced local spillover effects do account sufficiently for spatial dependencies in market orientation.

< Table 5 about here >

A different picture emerges for the cross-regressive model of new housing supply. Here, the results of the aspatial model continue to hold, namely caps and urban growth boundaries increase new construction whereas restrictive zoning diminishes the amount of housing construction. However, for only two of these growth control policies, the spatially lagged variables also exert significant influences on new construction. Caps on population growth/homebuilding in neighboring localities increase the amount of construction in the own locality by about 25 percent, thus indicating a positive spatial spillover. In contrast, the model suggests a negative spillover for restrictive zoning. That is, restrictive zoning in neighboring localities lowers the amount of homebuilding in the own locality. The diagnostics for spatial dependence suggest that the cross-regressive model of new housing supply still suffers from positive spatial autocorrelation. We thus turn to an investigation of global spillover effects. Following the arguments of Section 3, we estimate a spatial error model, as suggested by the (robust) LM error-test of the aspatial model presented in Table 4. The results are shown in Table 6.

< Table 6 about here >

The results indicate that the spatial error coefficient is highly significant, suggesting positive global spillover effects. Interesting is also that – compared to the aspatial model – the estimated magnitude (and significance) of the growth control measures is substantially. Caps increase the new housing supply by 26 percent and urban growth boundaries result in a 31 percent increase (43 and 41 percent, respectively, in the aspatial model). Restrictive zoning, which in the aspatial model is estimated to reduce new supply by 26 percent, is expected to yield only a 20 percent decline when taking global spillovers into account. These results are strong evidence for the importance of global spillovers. However, the diagnostics suggest that further model modifications are necessary. Most importantly, all models presented here suffer from heteroskedasticity as evidenced by the highly significant Breusch-Pagan tests. This issue will be picked up in subsequent research.

5. CONCLUSIONS

This study investigates the effects of local growth controls in California housing markets, focusing specifically on spatial spillover effects. We target two housing market outcomes, that the literature identified as being influenced by growth controls, namely the supply of new housing and the market orientation of new supply. Using data for 420 jurisdictions in the State of California, we infer a number of interesting empirical results.

First, spatial spillovers play a prominent role in understanding the effects of growth controls on housing market outcomes. Spillovers may be confined locally, with effects only reaching into the immediate neighborhood. However, spillovers can also be global, that is they are being propelled throughout the entire spatial system of localities. Interestingly, our results suggest that the type of spatial spillovers for the two housing market outcomes differs. Market orientation of new home building is primarily influenced by local spillovers that are driven by just one type of growth control, namely caps on population growth and building permits. That is, caps tend to foster an upmarket trend of new homebuilding and this influence extends into the immediate neighboring localities. There is no evidence, however, for global spillovers. In contrast, for the supply of new housing the results suggest positive global spillover effects that spread throughout the entire spatial system of California localities.

Second, from a conceptual perspective, ignoring spatial spillover effects implies that jurisdictions are erroneously treated as closed, independent entities. Empirically, the results suggest that ignoring spatial spillovers tends to over-estimate the influence of growth controls on housing market outcomes (in the own locality).

Third, the empirical results emphasize that the effects of growth control measures differ substantially and do not always seem to coincide with their intended goals. Caps on population growth / building permits actually increase the amount of new construction. They also are the only growth control measure that leads to an upscale market trend for new construction. Urban growth boundaries have no effect on market orientation, but they strongly increase the amount of new construction. Unlike in the case of caps, this result is actually not counterintuitive since urban growth boundaries seek to contain growth within the boundary (Nelson and Moore 1993; Pendall 2000) but keep it unrestricted inside the boundary. Residential zoning restrictions are the only measures that reduce new construction, but they have no effect on the market orientation of new construction.

Future research will tackle the unsolved methodological issues, in particular deal with heteroskedasticity. Instead of mechanically correcting for it, we will emphasize the identification of sources of heteroskedasticity. This is of particular importance for spatial sources of heteroskedasticity, e.g., a north-south disparity or a coastal-inland disparity, as they will most strongly interfere with a proper evaluation of spatial spillovers.

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Table 1. Definition of and Frequency of Growth Controls

Growth Control Policy	*Definition*	*Proportion of California Communities with Policy (as of 1988)*
Housing Permit Cap or Population Growth Cap	To enforce the annual quota of housing building permits in order to slow rapid population growth and resulting increase in housing construction; Whether or not the quota is connected to annual target of population inflow differentiates between housing permit and population growth caps.	.14
Urban Growth Boundary	To contain growth (or housing construction) within a designated boundary for a predetermined period; To confine provision of public infrastructure or services within the boundary in order to inhibit housing construction outside the boundary	.18
Adequate Public Facility Ordinances	To require homebuilders or residential developers to provide sufficient public infrastructure in order to minimize impacts of new development on existing infrastructure	.30
Restrictive Residential Zoning	To suppress residential density for housing construction – reduction of permitted density, allocation of existing residentially zoned land to less intense uses (e.g., open space)	.29
Restrictive Zoning Approval	Required regulatory procedures (such as voter approval)	.12

Table 2. Spatial Autocorrelation of Growth Control Policies

Growth Control Policy	*z-value of Moran's I*	*% of Localities without growth control*	*% of Localities with growth control*
		for which at least one neighbor has growth control policy	
Housing Permit Cap or Population Growth Cap (CAPS)	5.704	31.2	62.0
Urban Growth Boundary (UGB)	3.827	48.0	72.4
Adequate Public Facility Ordinances (APFO)	2.425	60.8	72.6
Restrictive Residential Zoning (RZ)	2.558	58.3	75.8
Restrictive Zoning Approval (RZA)	1.517	49.3	63.3

Table 3. Average Housing Market Outcomes by Type of Locality

	Localities *without* growth policy		Localities *with* growth policy	
Housing Market Outcome	Type 1 Neighbors *without* growth policy (n=24)	Type 2 Neighbors: *with* growth policy (n=141)	Type 3 Neighbors: *without* growth policy (n=21)	Type 4 Neighbors: *with* growth policy (n=231)
New Supply (in % of existing housing stock); State average: 2.516	3.531	2.354	2.696	2.525
Building Material Costs; State average: $128,525	$100,020	$129,393	$114,058	$132,291

Table 4. Aspatial Models of Housing Market Outcomes (OLS)

Variables		*Market Orientation*		*New Housing Supply*	
		Coefficient	Std. Err.	Coefficient	Std.Err.
Intercept		2.625***	0.413	-3.117***	0.325
CAPS		0.097**	0.037	0.369***	0.131
UGB		-0.013	0.033	0.353***	0.118
APFO		-0.002	0.028	0.049	0.097
RZ		0.017	0.029	-0.309***	0.101
RZA		0.036	0.041	-0.054	0.141
STOCK				0.911***	0.034
INC		0.844***	0.043		
POPG		-1.090***	0.396	14.003***	1.377
HPG		5.900***	1.833	-39.225***	5.341
METRO		0.088**	0.042	-0.111	0.132
Regression Diagnostics [b]	n	417		420	
	adj. R^2	0.682		0.707	
	Condition Number	117.245		23.837	
	J-B Test (p-value)	0.636		6.078 **	
	B-P Test (p-value)	19.102 **		38.293 ***	
Test for Spatial Dependence[ab]	Moran's I	2.008 **		5.473 ***	
	LM-error	3.020 *		26.171 ***	
	Robust LM-error	2.254		20.046 ***	
	LM-lag	0.924		6.910 ***	
	Robust LM-lag	0.157		0.784	

[a] The tests are based on a row-standardized binary queen contiguity matrix. Alternative specifications for the weight matrix, such as distance band contiguity matrices, yield similar results.

[b] J-B test: Jarque-Bera test on normality of errors; B-P test: Breusch-Pagan test on heteroscedasticity; LM-LAG: Lagrange multiplier test on spatial lag dependence; LM-ERR: Lagrange multiplier test on spatial error dependence; Robust LM-LAG: robust Lagrange multiplier test on spatial lag dependence; Robust LM-ERR: robust Lagrange multiplier test on spatial error dependence.

*, **, *** indicate significance (2-tail) at the .1, .05, and .01 level, respectively.

Table 5. Spatial Cross-regressive Models of Housing Market Outcomes (OLS)[a]

Variables		*Market Orientation*		*New Housing Supply*	
		Coefficient	Std. Err.	Coefficient	Std.Err.
Intercept		2.595***	0.413	-2.055	0.554
CAPS		0.075*	0.038	0.282**	0.133
W CAPS		0.172***	0.050	0.223	0.174
UGB		-0.019	0.033	0.351***	0.117
W UGB		-0.023	0.038	-0.016	0.134
APFO		0.002	0.028	0.045	0.096
W APFO		-0.051	0.040	0.039	0.141
RZ		0.011	0.029	-0.291***	0.099
W RZ		0.014	0.043	-0.418***	0.148
RZA		0.032	0.040	-0.077	0.138
W RZA		-0.026	0.049	-0.045	0.168
STOCK				0.879***	0.034
W STOCK				-0.093*	0.047
INC		0.854***	0.043		
W INC					
POPG		-1.191***	0.394	12.874***	1.393
W POPG				7.303***	2.007
HPG		4.222**	1.936	-35.133***	5.812
METRO		0.061	0.043	0.031	0.146
Regression Diagnostics	n	417		420	
	adj. R^2	0.689		0.723	
	Condition Number	140.458		51.012	
	J-B Test (p-value)	3.457		5.026 *	
	B-P Test (p-value)	32.010 ***		23.565 *	
Test for Spatial Dependence[a] (p-value)	Moran's I	1.694 *		5.671 ***	
	LM-error	1.886		26.186 ***	
	Robust LM-error	1.329		0.486	
	LM-lag	0.733		27.471 ***	
	Robust LM-lag	0.177		1.771	

[a] see footnotes for Table 4

Table 6. Spatial Error Model of New Housing Supply (MLE)[a]

Variables		*Spatial Error Model*	
		Coefficient	Std. Err.
Intercept		-3.289***	0.343
λ (spatial error coeff.)		0.377***	0.052
CAPS		0.239*	0.124
UGB		0.278**	0.108
APFO		0.064	0.091
RZ		-0.180*	0.093
RZA		0.0121	0.126
STOCK		0.938***	0.031
POPG		11.213***	1.301
HPG		-44.870***	7.403
METRO		-0.160	0.173
Regression Diagnostics	n	420	
	R^2	.716	
	B-P Test (p-value)	22.198 ***	
	Spatial B-P Test (p-value)	22.201 ***	
	Like-Ratio	33.957 ***	
	LM-lag	2.945 *	
	LM-error		

[a] see footnote for Table 4.

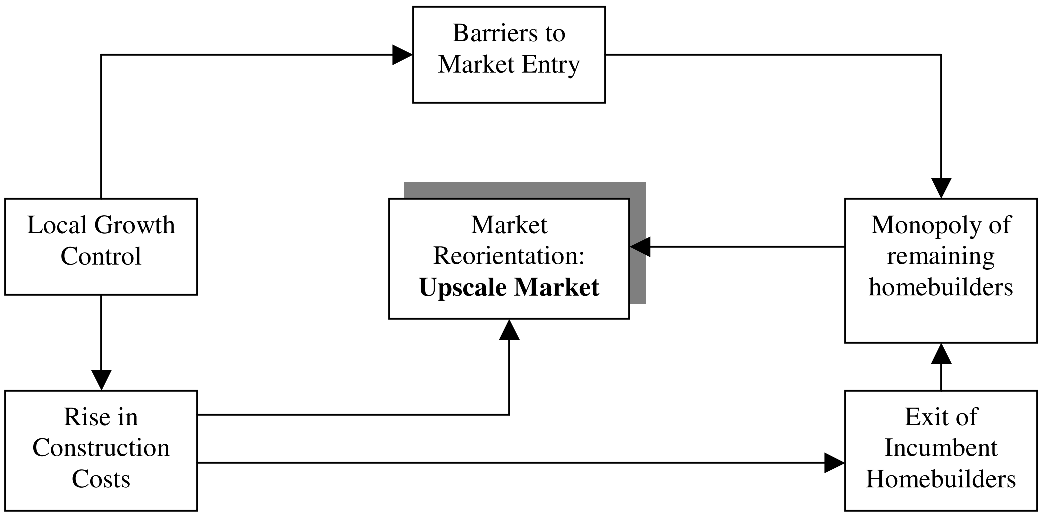


Figure 1. Local growth control-induced upscale market trend

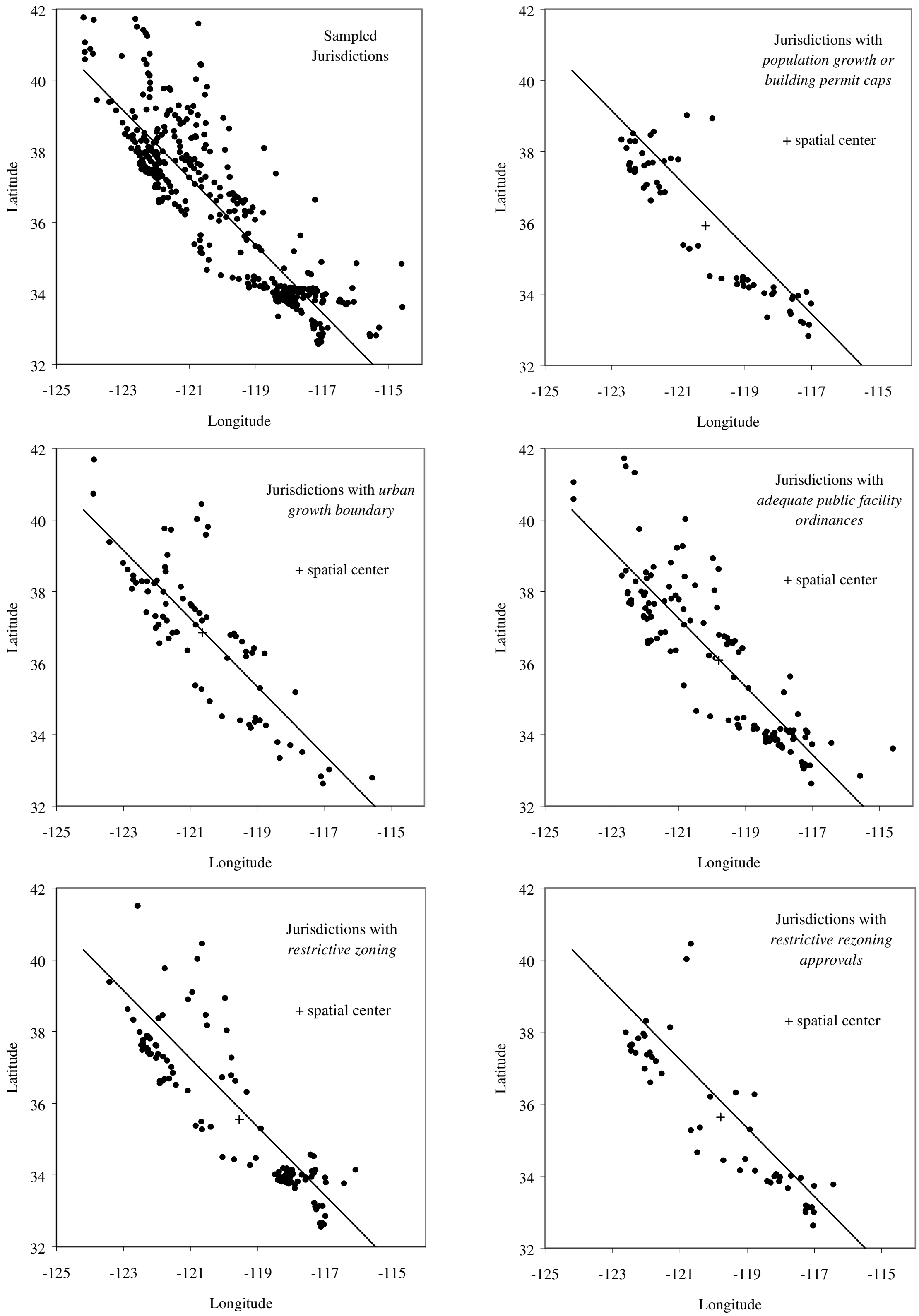
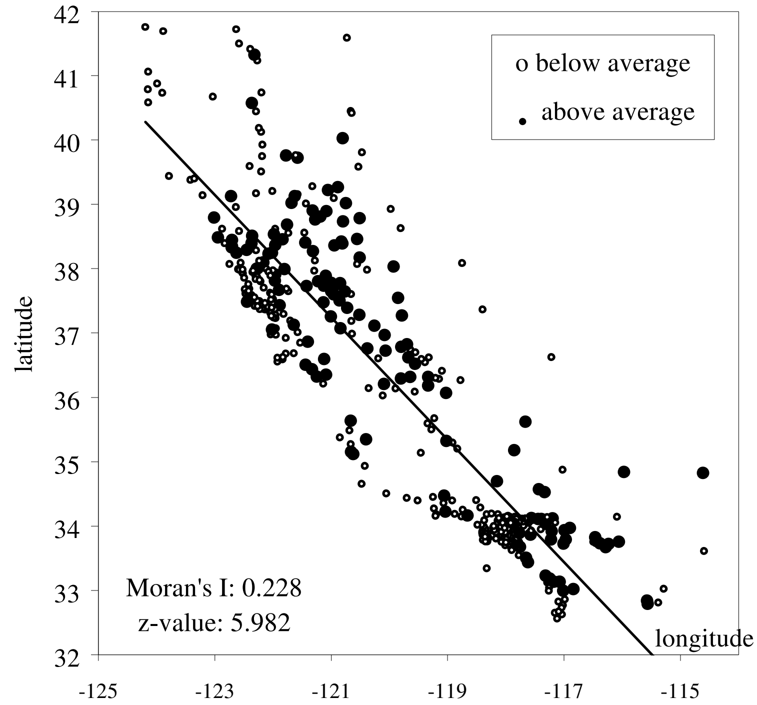
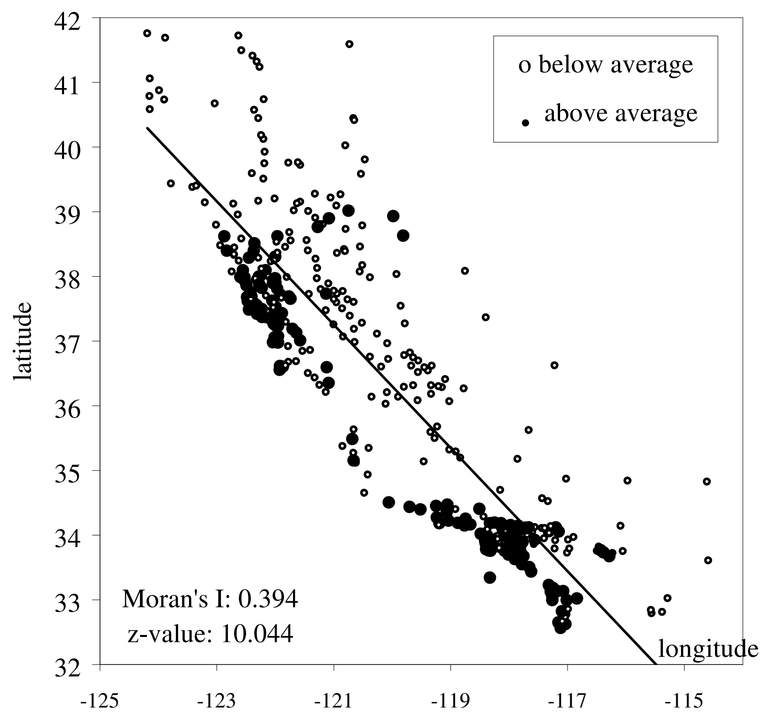


Figure 2. Spatial Distribution of Growth Controlled Localities



New Permits in % of Existing Housing Stock



Material Cost for New Construction

Figure 3. Spatial Distribution of Housing Market Outcomes