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Parsing Density Changes: An Outcome-Oriented Growth Management Policy Analysis

Abstract: Although a considerable number of studies have examined the effectiveness of growth management programs in curbing sprawl and increasing aggregate densities, less attention has been paid to understanding how these noted density improvements are realized. In this paper, we assess the mechanisms that underlie changes in aggregate population densities and empirically examine detailed density changes under various growth management regimes in the U.S. Our county-level statistical analysis using recent U.S. Census products and land use change data sets, finds that: a) states with proactive growth management programs do tend to experience relative density gains, but not in jurisdictions with restrictive local land use regulations and b) the marginal density gains appear to be attributable in large part to smaller housing vacancy rates and housing price escalations. Not surprisingly, our findings suggest that local structures are critical for achieving desired outcomes. Given the critical role of local action, the realization of compact development requires a tightly woven and integrated policy that not only makes logical sense at state levels, but can be followed and implemented at the local level.

Keywords: Growth Management; Compact Development; Density; Housing Vacancy; Housing Price; Affordable Housing; State-Local Interaction

1. Introduction

Over the past several decades, American cities have expanded and transformed at dramatic rates. Rural landscapes are rapidly changing to suburban land uses, while central city neighborhoods are in decline. In addition, commercial strip development and suburban and exurban leapfrog development are becoming the norm. These patterns of spatial expansion, usually called 'sprawl', have been seen as a cause of many urban problems, such as long distance commute, environmental disruption and fragmentation, central city decline, segregation, inefficient public service provision, and so forth (Ewing, 1994; Bontje, 2004; Burchell *et al*., 2005). Many communities have attempted to address these undesirable consequences with programs aimed at managing growth and eliciting more compact development. In the U.S., state governments are also increasingly engaged in such efforts, implementing statewide growth management programs designed to guide, support, or even mandate local- and regional-level planning efforts for managing growth.

As the implementation rate of state level growth management programs in the U.S. increases, the research that addresses their efficacy similarly flourishes. The early literature on evaluative techniques typically assessed a growth management program's impact by analyzing the regulatory and governing practices of local decision bodies. These included: the stringency of planning requirements, the frequency of plan review, the observable qualities of local plans, and the horizontal consistency among plans in a region (see Gale, 1992; Meck, 2002; Talen and Knaap, 2003 for a more detailed discussion). More recent studies have focused on evaluations that are based on program outcomes. The types of outcomes measured (at least to date) has varied widely to include: effects on property market systems (Carruthers, 2002a); state expenditures and building permit approval rates – before and after program implementation (Lewis et al., 2009); changes in travel behavior (Rodriguez et al., 2006); and many others. The most common criterion for measuring the success of a growth management program however, has been the policy's impact on sprawl (see e.g., Nelson, 1999; Galster et al., 2001; Anthony, 2004), and the most widely used measure of sprawl has been density.

Identifying urban density increases (or decreases) can be meaningful for a number of reasons. Higher densities have been associated with: lower consumption of natural resources, transportation energy savings, a reduction in expenditures for infrastructure and other public services, and sustainable developments (see e.g., Ewing, 1994; Tosics, 2004; Burchell et al., 2005). While traditional growth controls and other local level regulations have been shown ineffective in promoting higher densities and in fact tend to promote lower density developments (Levine, 1999; Pendall, 1999; Chakraborty et al., 2010), state-level growth management policies are being established as a counteractive measure with high expectations for inducing higher densities (Carruthers, 2002b; Downs, 2005). It has been argued that effective growth management policies can (among other things): create opportunities for affordable housing developments (Knaap and Nelson, 1992), lead to an urban form that can support mass transit (Downs, 1994; Orfield, 1997), and reduce the costs of public services (Burchell et al., 2005). In addition, statewide guidelines and incentives for cooperation can help communities avoid the 'spillover effects' of leapfrog development patterns that can occur in areas with uncoordinated local regulation (Downs, 2005).

Therefore, studies on the effectiveness of state level growth management programs have focused on cross sectional assessments of aggregate density changes as a measure of success or failure. Although important, this form of inquiry has limited usefulness for understanding *how* the policies being tested are accomplishing their goals. In order to affect a broader policy discussion, understanding *how* density gains are achieved is a critical question. Furthermore, previous studies often test the effect of state-level programs on density changes without controlling for local influences. Local development regulations vary significantly within a single state and are critical for shaping development processes. Found density changes can be the result of a variety of urban phenomena with varying elasticity to policies. Understanding these phenomena and their relationship to policy requires a closer investigation of the *how* question and the underlying factors that ultimately lead to changes in aggregate densities.

This paper attempts to add to the literature on the effects of growth management programs on housing and the built environment by investigating the underlying factors that might contribute to critical changes in urban densities. We do this by confronting the *how* question – *how* are the found density increases achieved? (i.e., *what* are the attributes within a growth management program that permit density increases to occur?) We hypothesize that for conditions of improved densities we would find: higher occupancy rates; a higher percentage of high density housing units; and a greater efficiency in infrastructure utilization – an indicator of more compact development.

We test our hypothesis by first decomposing density into four, basic component variables: 1) housing occupancy (or vacancy) rate, 2) household size, 3) housing unit densities, and 4) non-residential developed land use efficiencies. We then examine changes in the decomposed variables under various growth management regimes through a regression analysis of 216 counties in eight states – four states with a considerable history of state level growth management policies (Florida, Maryland, Oregon, and Washington) and four states without (Illinois, Michigan, North Carolina, and Virginia). Our analysis results with the use of recently published U.S. Census and land use data indicate that the states with growth management policies have succeeded in achieving relative density improvements, but that the density increases are largely associated with occupancy rate increases and/or housing price inflations. We also found that counties with restrictive local land use regulations were less likely to exhibit density gains.

2. Density Improvement & Growth Management

The first figure in *Smart Growth Policies: An Evaluation of Programs and Outcomes* (Figure 1.1, Ingram et al., 2009) shows that the average acres of developed land per person in the U.S. has "increased from 0.32 acres in 1982 to 0.38 acres in 2002" (p. 3). This means that population density declined from 3.13 persons per acre of developed land in 1982 to 2.63 persons in 2002. This simple indicator (i.e., aggregate population density or its inverse) is often used as a barometer for determining the effectiveness of smart growth initiatives or growth management policies (see e.g., Nelson, 1999; Carruthers, 2002b; Anthony, 2004).

Although very useful, aggregate population density may not adequately depict changes in urban environments under different policy conditions. For instance, it does not distinguish differences within sub-geographic regions with the same population to developed area ratio, even though this ratio might be the result of completely different structural components. In such cases, the variation in internal structure might be captured by other measurements, such as inequality and/or spatial autocorrelation indicators (for example, see Tsai, 2005). Using aggregate population densities for policy evaluation purposes is also not ideal because net density changes represent a number of complex urban processes at a variety of scales. This is important because governments at all levels influence these processes through direct regulation, indirect incentives, and infrastructure investment decisions. In order to effectively evaluate how policy implicates population density, we first ascertain the fundamental building blocks of density.

The following is a simple mathematical decomposition of aggregate population density into our noted key component variables: housing occupancy rates, household size, residential land area per dwelling unit, and non-residential land use efficiency.

2.1. Density Components

Population density is defined as total population (*P*) divided by total area of developed land (*L*) for a certain geographic unit.

$$D = \frac{P}{L} \qquad (1)$$

The denominator (i.e., total area of developed land: *L*) can be decomposed into two broad categories—developed land for residential uses (L_R) and developed land for non-residential uses (L_{NR}), which include commercial-industrial purposes as well as built infrastructure, such as roads, parking spaces, etc. – as shown in Equation 2.

$$L = L_R + L_{NR} \qquad (2)$$

Developed land for residential uses (L_R) can be expressed using average developed residential land area per housing unit (*l*), housing occupancy rate (*o*), average household size (*h*), and total population (*P*), as demonstrated in Equation 3, where *U* and *H* represent the number of housing units and households, respectively.

$$L_R = l \cdot U = l \cdot \frac{H}{o} = l \cdot \frac{P}{o \cdot h} \qquad (3)$$

Also, let us define r as the ratio of developed land for residential uses (L_R) to total developed land (L) in a geographic region.

$$L_R = r \cdot L \Rightarrow L = \frac{1}{r} \cdot L_R \tag{4}$$

Then, density (D), which is the ratio of population to total area of developed land, can be shown as:

$$D = \frac{P}{L} = \frac{P}{\frac{1}{r} \cdot l \cdot \frac{P}{o \cdot h}} = \frac{o \cdot h}{l} \cdot r \tag{5}$$

Equation 5 implies that population density can be influenced by several factors: 1) housing occupancy rate (o), 2) average household size (h), 3) developed residential land area per housing unit (l), and 4) the ratio of developed land for residential uses to total developed area (r). More detailed discussion follows in the next section.

2.2. Density Components and Growth Management

Although changes in any of the four components can induce a change in population density, not all are equally responsive to growth management policies. This section discusses each component, its meaning, and its growth management policy implication.

2.2.1. Housing Occupancy (or Vacancy) Rate

Housing vacancies are due in part to residential mobility and relocation dynamics, and the large degree of heterogeneity and imperfect information in housing market systems (Gabriel and Nothaft, 1988; Nieboer and Voogd, 1990; Belsky, 1992). Moreover, vacancy rates fluctuate as a result of housing supply-demand interactions and market adjustment processes (White, 1971; Forrest and Murie, 1994; Wood et al., 2006). Despite natural fluctuations, a trending increase in housing vacancy rates can be an indicator of a range of generally negative issues including over heated markets, abandonment, or neighborhood decline (Van Grunsven, 1991; Accordino and Johnson, 2000; Cohen, 2001).

In the U.S., observations suggest that housing vacancy rates have been on the rise, increasing significantly over the past three decades (Figure 1). This suggests that: a) housing units are being supplied at a rate that exceeds demand, b) the percentage of seasonally occupied units is increasing, c) housing units are being abandoned, or d) an overheated housing market has lead to the wide-scale movement of housing occupants.

<< Figure 1 about here >>

Arresting such trends can be considered within the purview of growth management policies that attempt to "accommodate growth sensibly" (Downs, 2004, p.3) and "promise more certainty" (Nelson and Peterman, 2000, p.280). For example, programs that promote reuse and redevelopment of existing housing stock while controlling excessive new development can increase housing occupancy rates (i.e., reduce vacancies that are a result of new housing supply overreaching demand). Vacancy might also be addressed by growth management policies (e.g., impact fees and other land use based programs) that internalize the gap between the social costs and private costs of new development, as housing units in urban areas are less likely to be abandoned or left temporarily vacant when housing prices are able to capture these internalized social costs (Lillydahl and Singell, 1987; Kim, 2011).

2.2.2. Household Size

If all other factors are held constant (i.e., under the same vacancy rates, developed residential land per housing unit, and non-residential developed land uses), population density increases with an increase in household size (see Equation 5). The converse of this can be seen in the current demographic trends in many industrialized societies where population density is decreasing very directly in relation to shrinking households. Although household size may not be significantly affected by growth management policy implementation (and therefore not a critical part of this analysis), understanding the proportion of density changes that might be attributable to household size changes is important for a more comprehensive understanding of a growth management policy's impact.

2.2.3. Housing Unit Density

Population densities will increase as housing unit densities increase—that is, as developed residential land per dwelling unit (l) decreases. Simply increasing the share of higher density or multifamily units in a region is a way to increase population density. Growth management policies attempt to do this in various ways, including incentivizing multi-family development (Burchell and Galley, 2000) or adding inclusionary zoning requirements (Bento et al., 2009).

Housing unit densities might also be expected to increase if land prices or development costs increase under growth management programs. From a supply perspective, as land prices increase housing developers may begin to alter the ratio of land to per unit investment in order to economize production (Evans, 2004). This implies that, *ceteris paribus*, land developers might supply higher-density housing units as land prices increase. From a demand perspective, as housing costs rise, consumers might be more likely to choose smaller, more compact units in order to manage their housing expenses (Skaburskis, 2000). There is some empirical evidence in support of these shifts. In their analysis of Portland, Oregon, Philips and Goodstein (2000) reported that from 1991 to 1995, average residential lot sizes fell by between 13% and 20% in the counties within the region (p. 336). Similarly, in cities in the countries where development regulations are more restrictive and land availability more limited, land and housing prices are comparatively high, individual housing units tend to be smaller, and there tends to be a higher percentage of high-density buildings.

There are however, important caveats. In the U.S., multifamily unit developments may not be uniformly well received and may even be "zoned out" of many communities (Baar, 1996; Levine, 2006; Ryan and Enderle, 2012). The presence of these types of regulatory barriers combined with an increase in housing prices can also generate affordable housing problems (Dawkins and Nelson, 2002, p.2). This housing affordability issue has become one of the most significant challenges in places implementing regulatory growth management programs (see e.g., Staley and Gilroy, 2001; Nelson et al., 2004).

2.2.4. Non-Residential Land Use Efficiency

Developed land is also required for non-residential uses: production, trade, transportation, education, leisure, and so forth. The amount of land and ways in which it is used for non-residential purposes in an urban area is partly determined by factors that are not closely related to growth management policies – a city's industrial structure is one example. It is also partly determined however, by the efficient (or inefficient) use of land use for built infrastructure needs – that are directly related to growth management policies. Contiguous and less-dispersed development can economize on the need for land consumption for infrastructure purposes, suggesting a more efficient delivery of public services as one benefit of growth management policies (Ewing, 1994; Burchell et al., 2005).

An infrastructure efficiency gain can also be expected with an increase in mixed land uses. Mixed use can reduce the level of spatial mismatch, travel requirements, and the subsequent need for physical infrastructure. It also follows that over the long term, people become less dependent on automobile use, which means fewer roads and parking demands, leaving larger areas to be used for other purposes. Clearly then, as one unit of developed land is used more effectively within a growth management paradigm, we can expect to see resultant increases in population density, that is the inverse of per capita developed land consumption. Improvements in population densities that are achieved in concert with a more efficient infrastructure can also become part of a positive feedback loop by supporting other activities such as trip chaining, and infrastructure services such as mass transit – that in turn, help promote improved densities.

3. Empirical Analysis

In this section, we empirically analyze how density changes are realized under various growth management regimes in the U.S. by using the component variables. To do this, we select four states with a considerable history of state-level growth management policies and four states without. We then analyze the counties within these eight states to examine how density changes have been realized in relation to state-level growth management initiatives and local land use regulations. In doing so, we demonstrate that different growth management approaches can have differing effects on each of the components.

3.1. State Level Growth Management Characterizations

The *Growing Smart Legislative Guidebook* (Meck, 2002) presents an overview of state statutory requirements for local comprehensive plans by reviewing all 50 states from a number of perspectives. More specifically, Meck (2002) asks four questions "1) How up-to-date are the [state] laws…?; 2) Can the statutes be ignored or are they mandatory?; 3) How complete are the statutes in terms of plan elements?; and 4) How strong are the state roles in supporting local planning?" (Meck 2002, p. 7-277). These questions become the basis for characterizing each state from a planning and growth management perspective. In Carruthers (2002b) and in Dawkins and Nelson (2003) whether or not, and how planning consistency is ensured is the critical characterization variable. Other approaches to characterizing states from a growth management perspective include: Gale (1992), Porter (1996), Weitz (1999), Sierra Club (1999), Anthony (2004), and Ingram et al. (2009). Drawing from all of these characterization approaches we chose: a) four states that demonstrated the strongest state commitment to growth management policies – Florida (FL), Maryland (MD), Oregon (OR), and Washington (WA); and b) four states that might be considered to represent the other end of the spectrum – Illinois (IL), Michigan (MI), North Carolina (NC), and Virginia (VA). In the Sierra Club's 1999 report, *Solving Sprawl*, the four selected growth management states were considered among the top states (1^{st}, 3^{rd}, 5^{th}, and 11^{th}) in terms of land use planning efforts to control sprawl and promote more desirable development patterns. In contrast, the selected non-growth management states were considered among the least proactive states (26^{th}, 28^{th}, 47^{th} and 49^{th} respectively). Although the growth management vs. non-growth management dichotomy is not ideal, this approach is well described and used in the literature for quantitative studies assessing policy outcomes (Carruthers, 2002b; Dawkins and Nelson, 2003; Anthony, 2004).

3.2. Analytical Framework

Although state level initiatives set broad policy standards, in general, they influence development patterns largely through local governments' regulatory and enforcement structures. These structures are not always well coordinated with statewide initiatives and can vary widely both from state to state and also within a specific state. Additionally, local municipalities often implement land-use regulations that are not well coordinated with statewide initiatives. These types of local actions need to be taken into account when analyzing state-level planning programs, otherwise local action's impacts might get misinterpreted as state-level program effects.

Our regression analysis framework (Figure 2) is designed to measure the effects of state-level initiatives that take place in combination with local land use regulations by controlling for other factors. More specifically, we employ a log-linear formulation:

$$\ln Y = \ln X \cdot \beta_X + \beta_S \cdot S + \beta_L \cdot L + \beta_{SL} \cdot S \cdot L + \varepsilon \qquad (6)$$

Y represents the detailed components of density changes; *S, L, and S·L* are state-level growth management policy variables (*S*), local land use actions (*L*), and their interplays (*S·L*); *X* represents the independent variables to be controlled for; β represent corresponding parameters; and ε is an error term.

<< Figure 2 about here >>

3.3. Variables & Data

Because growth management policies may not generate a substantial change in household size within a short period of time, we focus our analysis on: housing vacancy rates, housing unit densities, and non-residential developed land use efficiencies between 2001 and 2006. Specifically, we assess how changes in the above metrics can be attributed to state-level growth management and local land use regulation regimes.

Housing vacancy rates are computed (by county) using U.S. census data. Assessing housing unit densities and non-residential land use efficiencies however, requires aspatial and spatial data that are difficult to obtain uniformly for a large number of counties. Although the total area of developed land in 2001 and 2006 can be calculated using the U.S. Geological Survey's National Land Cover Dataset (NLCD), we could not accurately classify the developed land into residential and non-residential uses for each county in the selected states using this data. Therefore, we use housing units per developed land (*r/l*), a composite of housing unit density (*1/l*) and non-residential developed land use (*r*), instead of the two separate component variables. This new variable simplifies our regression analysis by reducing the number of dependent variables to the log of change rates in i) vacancy rates and ii) in housing units per developed land between 2001 and 2006.

In our analysis state-level growth management policy initiatives (*S*) are represented by a *GM* indicator variable that describes whether (1) or not (0) the county is in one of the four selected growth management states. To capture the variation in local land use regulation and implementation (*L*), we use a recent version of the Wharton Residential Land Use Regulatory Index (*WRLURI*) (Gyourko et al., 2008). This index quantifies the 'restrictiveness' of local land use regulations for more than two-and-a-half thousand localities in the U.S. It is based upon eleven sub indexes that approximate the various regulations and decision making processes that can potentially restrict and/or delay residential development procedures in a specific place (Gyourko et al., 2008). For example, it measures a locality's density restrictions, open space requirements, and duration of the review process. Using surveys and other information, the index also considers how long it takes to get zoning change approval, whether or not a locality implements certain regulatory measures such as minimum lot-size zoning and building permit caps, as well as the local public's involvement in the permitting or approval processes.

We acknowledge that a single index cannot perfectly represent or quantify the complexity of local land use regulations. In addition, *WRLURI* tends to view local land use actions from the developer's perspective – as a set of barriers rather than focusing on the intent that created the interventions. Nevertheless, the *WRLURI* is a useful tool capturing the variance in local land use interventions. It is consistently applied; it uses objective standards to measure and synthesize various elements of local land use policies; and it utilizes a wide geographic coverage and large survey sample size.

In this study, we calculate the weighted average of *WRLURI* for each county in our study area based upon the land area covered by the individual places reported in the index. Since one component of *WRLURI* is state-level engagement, the cities and towns in the growth management states are more likely to have higher index values (indicating stronger local regulations). To deal with this correlation and to reflect the mechanism of the state-level action's effect on development through local entities, we use the interactive variables ($S \cdot L$), combining *WRLURI* and *GM* (i.e., *GMWRLURI)*.

Finally, to control for other factors that can affect the two dependent variables, we use data from some U.S. Census products, the Regional Economic Information System (REIS), U.S. BEA (Bureau of Economic Analysis), and Local Area Unemployment Statistics (LAUS), U.S. BLS (Bureau of Labor Statistics). More specifically, for Year 2006 data values, we employ the 2005-2007 American Community Survey (ACS) 3 Year Estimates. As opposed to the 2006 ACS

1-Year Estimates that cover relatively fewer counties, the 3-Year Estimates allow us to increase sample size. For Year 2001, given that no comprehensive ACS exists, we utilize the Census Annual (Population and Housing) Estimates and Census 2000 information. Table 1 summarizes dependent and independent variables used in this analysis, along with data sources.

<< *Table 1 about here* >>

There are a number of sparsely populated rural counties for which 2005-2007 ACS or *WRLURI* information is not available. These are not considered in our regression analysis. Our final sample set includes 216 counties in the 8 states. Descriptive statistics of the variable set tested are presented in Table 2. On average, the four growth management states are more likely to show better performance in improving density components and thus the aggregate population density as shown in the table.

<< Table 2 about here >>

3.4. Analysis Outcomes

As described previously, housing vacancies and housing unit densities can be influenced both by growth management directly and through housing market price escalation. Therefore, for each dependent variable (i.e., the log of change rates in i) vacancy rates and ii) in housing units per developed land between 2001 and 2006), we estimate two regression models with (Model 1) and without (Model 2) controlling for housing price variables.

Results for the logarithmic value of vacancy change rate analysis (i.e., the first dependent variable) are presented in Table 3.

<< Table 3 about here >>

The results for Model 1 show a significant, negative coefficient for vacancy rates in 2001. This suggests a fluctuating vacancy rate with an equilibrating adjustment process is present. Not surprisingly, we also found that the vacancy rates were more likely to increase in the counties with higher percentages of developed areas. The positive coefficient of *ln(PCI01)* (i.e., per capita income level in 2001) indicates vacancy rates went up in higher income areas over our study period. This may be attributable to a higher residential mobility in the areas – large numbers of buyers and sellers that leave units vacant for a fractional point in time.

Of interest are the effects of the policy variables that represent growth management and other local land use actions. We found that the presence of the growth management variable has a statistically significant (0.1% level) negative effect on the vacancy rate changes. This suggests that counties in the four growth management states are more likely to have slower increases in vacancy rates than the non-GM counties in our control group. Our local policy variables (*WRLURI* and *GMWRLURI*) do not show significance, suggesting that local land use regulation has little influence on systematic variation in vacancy rate changes regardless of its GM status.

When additional variables (*ln(MHVPCI01)* and *ln(MHVPCICHR)*) are included in Model 2 to control for the effect of housing price (normalized by the per capita income level of the county), the presence of the growth management variable remains significant and negative in terms of its influence on vacancy rates. The estimated coefficients however, become slightly less significant with smaller magnitudes. This is associated with the significant, negative effects of the newly included variable: *ln(MHVPCI01)*, indicating that housing units are less likely to be vacant when housing prices are high. Counties in growth management states were more likely to exhibit higher housing prices and lower vacancy rates in the sample of this empirical analysis.

Analysis of the second dependent variable, the rate of change in housing units per developed area, reveals a slightly different story (Table 4). In Model 1 where housing price variables were not controlled, we found (similar to our first analysis) that the presence of growth management policies had a significant positive effect on density. In contrast, testing for local effects (*GMWRLURI*) showed significant negative consequences. Assuming that the proportion of non-residential urban land uses (e.g., commercial and industrial lands) to total developed area (i.e. the existing ratio of developed land uses) may not shift significantly within our 5 year analytical window, these results together suggest that higher density units may be more likely to be built in the four growth management states, but perhaps not in all areas of the states. This implies that even in the presence of state policies, density improvements might not be realized in counties with a) strong local controls (e.g., minimum-lot size requirements, building permit caps, etc.) or b) a propensity to resist change through local mechanisms like political action or a slow response to zoning change approvals.

<< Table 4 about here >>

When housing prices are controlled for in Model 2, the presence of growth management policies becomes insignificant in affecting density changes. Instead, the housing price change rate variable (*ln(MHVPCICHR)*) shows a significant positive effect. This supports the notion discussed by Nelson et al. (2004) and Quigley et al. (2008) that growth management may increase housing prices; and that higher prices induce relative density gains. In other words, growth management policies indirectly contribute to housing unit density improvements by affecting pricing structures. This link, however, should be interpreted carefully. While there is a significant difference between the two groups in terms of both housing price levels and price increase rates, there are many other demand and supply side factors determining the price level.

For example, as Phillips and Goodstein (2000) show in the case of Portland, OR, price effects could be linked to reduction in the size of new single-family homes and greater share of multi-family construction.

Finally, we should note that in this case, unlike the case of housing vacancy rates, the *GM* dummy no longer exhibits a significant effect. This may suggest that the provision of higher density units beyond the market outcome induced by housing price increases is not really substantial in the growth management states. Furthermore, the negative and significant effect of the *GMWRLURI* reinforces the notion that higher-density units are less prevalent in areas with strict local controls and that local units might (continue to) favor low-density unit developments, even in growth management states and in the face of housing unit price increases.

3.5. Discussion

Generally, counties in the states with growth management policies are more likely to have relative density improvements than those without such interventions. How these density improvements are achieved however, is significant. In our study, the differences in density changes between growth management and non-growth management conditions can be attributed to multiple mechanisms. One is vacancy rate improvements – areas with state-level growth management initiatives exhibited lower vacancy rates. It also appears that the relative density gains in growth management regimes are associated with higher housing unit densities. But, the density improvements realized through housing unit density increases seem to be weaker than expected – our analysis found no significant evidence of housing unit density increases beyond the effect of housing price escalation in the growth management areas. In particular, higher-density units are also less prevalent in areas with strict local controls.

A number of prior studies (Talen and Knaap, 2003; Burchell and Galley, 2000) have described the importance of local controls in shaping land use decisions. In our analysis, we find a significant effect of *GMWRLURI* in determining housing unit densities, although the local regulatory index does not show significance in the case of occupancy rates. This may support the old adage – all development decisions are local – even in the presence of state level policies. This is critical for understanding a significant part of our *how* question. If density improvements are largely a function of local structures, then the vertical integration of growth management policy implementation becomes essential. Given the critical role of local actions, the realization of compact development may require a tightly woven and integrated policy that not only makes logical sense at state levels, but can be followed and implemented at the local level.

4. Conclusions

In this paper, we investigate the underlying factors that might contribute to critical density improvements and examine how growth management programs help our communities achieve density goals. This is accomplished by decomposing aggregate density changes into four component variables – 1) housing occupancy (or vacancy) rates, 2) household size, 3) housing unit density, and 4) non-residential developed land uses. We employ three of these component variables (less household size) to analyze how density gains or losses have been realized in the presence or absence of growth management policies using newly published datasets that provide us with an opportunity to assess the performance of some growth management initiatives.

Our findings suggest that although growth management policies appear to affect relative densities, vacancy rates play a large role in that determination. We also found that price escalations, commonly found in growth management areas, may play a critical role in inducing density improvements. We also note the significance in vertical policy integration if we hope to affect 'local' development decisions.

Additionally, we found value in the decomposition of a large scale or aggregate variable and that understanding the dynamics of the local condition can help us understand 'how' or even 'if' things are really working the way we think they are. Our decomposition of density into component variables helped us better understand *how* reported aggregate density changes were being achieved. It also helped us analyze not only where these policies are having an effect, but how that affect is being achieved.

Currently a considerable portion of growth management states' achievement in gaining critical density improvements appears to be through implicating occupancy and its associated vacancy rate. Impacting density changes through this means is effective, but perhaps marginal and not necessarily robust over the long term. Smart growth advocates may wish to channel their efforts toward more effective approaches to improving density; increasing the provision of affordable higher density units and enacting local regulations that requires a more efficient use of serviced land for example. Policies developed to affect these changes need to be integrated from top-to-bottom and bottom-to-top if they hope to become salient. The more tangible, locally scaled solutions that are derived from this vertical integration will prove to be, over the long haul, more sustainable.

Follow-on work to this study should include more detailed analysis of the mechanisms of the built environment changes under various policies over a longer time period (as data becomes available). Careful consideration of the variation in state-level approaches, policy implementation structures, and other contextual situations can also reveal why policy outcomes are not as successful as expected. In this line, more detailed analysis is also needed on state and local policy integration – what works, what doesn't. Understanding complementarity and conflicts between state-level initiatives and local actions can lead to a more meaningful policy reform.

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Table 1. Variables & Data

Category	Variable	Description	Data Sources
Dependent Variables (*Y*)	*VRCHR*	Rate of change in vacancy rate between 2001 and 2006	Census 2000, 2005-2007 ACS, Census Annual Estimates
	HUDCHR	Rate of change in the number of housing units per developed land between 2001 and 2006	NLCD 2001 and 2006, Census 2000, 2005-2007 ACS, Census Annual Estimates
Policy Variables (*S*; *L*; *SL*)	*GM*	Growth management indicator (1: All counties in FL, MD, OR, and WA | 0: Otherwise)	
	WRLURI	Wharton Residential Land Use Regulatory Index	Gyourko et al. (2008)
	GMWRLURI	Interactive variable: *GM***WRLURI*	
Housing Price Variables (*X*)	*MHVPCI01*	Median value for specified owner-occupied housing units divided by per capita income (in Year 2001)	Census 2000, 2005-2007 ACS, REIS
	MHVPCICHR	MHVPCI06/MHVPCI01	Census 2000, 2005-2007 ACS, REIS
Other Control Variables (*X*)	*DLR01*	Ratio of developed land to total land area in 2001	NLCD 2001
	VR01	Vacancy rate in 2001	Census 2000, 2005-2007 ACS, Census Annual Estimates
	OWNR01	Ownership ratio in 2001	Census 2000, 2005-2007 ACS, Census Annual Estimates
	PCI01	Per capita income in 2001	REIS
	UNEMPR01	Unemployment rate in 2001	LAUS
	HUGR	Housing unit growth rate between 2001 and 2006	Census 2000, 2005-2007 ACS, Census Annual Estimates
	OLDHUGR	Rate of change in the share of old housing units (over 50 years) between 2001 and 2006	Census 2000, 2005-2007 ACS
	PGR9101	Population growth rate between 1991 and 2001 (i.e., previous 10 years)	Census Annual Estimates
	PCIGR	Per capita income growth rate	REIS
	UNEMPCHR	Rate of change in unemployment rate between 2001 and 2006	LAUS
	CENTRAL	Central county indicator (1: Central county of each MSA or PMSA according to 1999 definition | 0: Otherwise)	
	SUBMSA	Suburban county indicator (1: Suburban counties of MSAs or PMSAs according to 1999 Definition | 0: Otherwise)	

Table 2. Descriptive Statistics

Variable		All Eight States	Four GM States	FL	MD	OR	WA	Non-GM States	IL	MI	NC	VA
	Sample Size	216	79	30	10	20	19	137	35	43	46	13
Population Density Change Rate	Mean	1.032	1.068	1.098	1.034	1.056	1.051	1.012	1.002	1.008	1.020	1.023
	Stand. Dev.	0.059	0.070	0.099	0.029	0.039	0.025	0.040	0.048	0.026	0.042	0.048
ln(VRCHR)	Mean	0.191	0.116	0.199	0.149	0.020	0.069	0.235	0.244	0.214	0.263	0.181
	Stand. Dev.	0.172	0.146	0.095	0.103	0.130	0.174	0.172	0.146	0.197	0.157	0.194
ln(HUDCHR)	Mean	0.056	0.083	0.118	0.056	0.065	0.059	0.041	0.028	0.043	0.048	0.041
	Stand. Dev.	0.052	0.069	0.097	0.037	0.037	0.019	0.030	0.026	0.028	0.031	0.039
WRLURI	Mean	-0.075	0.329	0.321	0.760	0.039	0.420	-0.309	-0.530	-0.064	-0.420	-0.129
	Stand. Dev.	0.710	0.628	0.583	0.757	0.547	0.593	0.649	0.626	0.542	0.667	0.725
ln(MHVPCI01)	Mean	1.431	1.580	1.432	1.538	1.728	1.681	1.345	1.251	1.407	1.341	1.412
	Stand. Dev.	0.226	0.204	0.191	0.195	0.119	0.123	0.192	0.246	0.155	0.156	0.157
ln(MHVPCICHR)	Mean	0.154	0.264	0.327	0.413	0.196	0.156	0.090	0.100	0.131	-0.001	0.254
	Stand. Dev.	0.155	0.137	0.120	0.081	0.109	0.075	0.127	0.100	0.055	0.092	0.209
ln(DLR01)	Mean	-2.115	-2.249	-1.799	-1.763	-2.875	-2.555	-2.037	-1.974	-2.077	-2.194	-1.522
	Stand. Dev.	0.804	0.887	0.754	0.761	0.753	0.776	0.744	0.664	0.669	0.648	1.219
ln(VR01)	Mean	-2.360	-2.263	-1.929	-2.658	-2.446	-2.391	-2.415	-2.746	-2.279	-2.280	-2.454
	Stand. Dev.	0.542	0.573	0.443	0.562	0.559	0.543	0.516	0.293	0.637	0.415	0.505
ln(OWNR01)	Mean	-0.337	-0.366	-0.328	-0.351	-0.400	-0.400	-0.320	-0.319	-0.264	-0.342	-0.429
	Stand. Dev.	0.113	0.108	0.106	0.145	0.080	0.099	0.114	0.107	0.088	0.094	0.167
ln(PCI01)	Mean	10.371	10.441	10.497	10.542	10.366	10.379	10.330	10.377	10.296	10.312	10.380
	Stand. Dev.	0.205	0.230	0.284	0.170	0.133	0.210	0.177	0.192	0.168	0.155	0.219

ln(UNEMPR01)	Mean	-2.931	-2.906	-3.089	-3.191	-2.705	-2.680	-2.945	-2.963	-2.986	-2.778	-3.351
	Stand. Dev.	0.282	0.292	0.189	0.268	0.169	0.216	0.276	0.185	0.230	0.236	0.287
ln(HUGR)	Mean	0.081	0.106	0.151	0.087	0.078	0.072	0.066	0.065	0.054	0.081	0.060
	Stand. Dev.	0.069	0.081	0.108	0.043	0.047	0.025	0.056	0.073	0.031	0.060	0.045
ln(OLDHUGR)	Mean	0.199	0.246	0.379	0.160	0.182	0.148	0.172	0.112	0.136	0.217	0.293
	Stand. Dev.	0.160	0.194	0.206	0.139	0.149	0.118	0.130	0.107	0.115	0.102	0.186
ln(PGR9101)	Mean	0.135	0.183	0.225	0.112	0.165	0.172	0.107	0.077	0.084	0.164	0.064
	Stand. Dev.	0.115	0.112	0.124	0.113	0.098	0.081	0.107	0.121	0.080	0.100	0.097
ln(PCIGR)	Mean	0.169	0.205	0.254	0.193	0.176	0.165	0.148	0.151	0.118	0.156	0.214
	Stand. Dev.	0.063	0.062	0.061	0.028	0.040	0.045	0.053	0.051	0.044	0.046	0.043
ln(UNEMPCHR)	Mean	-0.082	-0.230	-0.322	-0.028	-0.174	-0.250	0.004	-0.088	0.266	-0.177	0.024
	Stand. Dev.	0.223	0.137	0.104	0.050	0.104	0.104	0.218	0.101	0.111	0.126	0.109
CENTRAL	Mean	0.255	0.354	0.500	0.200	0.250	0.316	0.197	0.229	0.186	0.217	0.077
	Stand. Dev.	0.437	0.481	0.509	0.422	0.444	0.478	0.399	0.426	0.394	0.417	0.277
SUBMSA	Mean	0.338	0.266	0.267	0.600	0.250	0.105	0.380	0.400	0.372	0.304	0.615
	Stand. Dev.	0.474	0.445	0.450	0.516	0.444	0.315	0.487	0.497	0.489	0.465	0.506

Table 3. Regression Analysis Result (Dependent Variable: Log of vacancy change rate between 2001 and 2006)

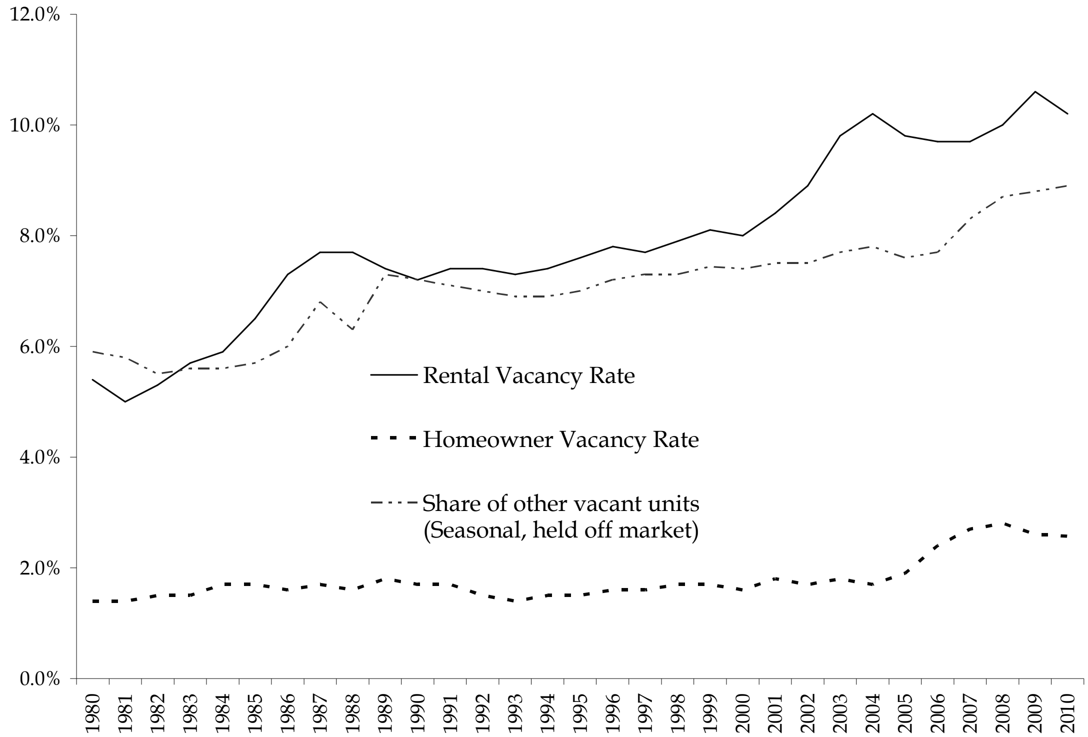
Variable	Model 1		Model 2	
	Estimated Coefficient	Standard Error	Estimated Coefficient	Standard Error
C (Intercept)	-1.485 *	0.784	-1.654 **	0.778
ln(DLR01)	0.040 **	0.019	0.028	0.020
ln(VR01)	-0.073 ***	0.026	-0.074 ***	0.025
ln(OWNR01)	-0.084	0.110	-0.143	0.111
ln(PCI01)	0.158 **	0.078	0.191 **	0.078
ln(UNEMPR01)	0.001	0.055	0.002	0.057
ln(MHVPCI01)			-0.153 **	0.061
ln(HUGR)	0.325 *	0.195	0.452 **	0.202
ln(OLDHUGR)	0.127 *	0.074	0.124 *	0.074
ln(PCIGR)	-0.306	0.248	-0.349	0.248
ln(UNEMPCHR)	-0.024	0.069	-0.0003	0.070
ln(MHVPCICHR)			-0.012	0.100
CENTRAL	0.006	0.037	-0.001	0.037
SUBMSA	-0.053	0.035	-0.043	0.035
GM	-0.122 ****	0.030	-0.091 **	0.037
GMWRLURI	0.038	0.035	0.029	0.035
WRLURI	-0.030	0.022	-0.018	0.022
R-squared	0.328		0.349	
Adjusted R-squared	0.282		0.297	

**** 0.1% level Significant | *** 1% level Significant | ** 5% level Significant | * 10% level Significant

Table 4. Regression Analysis Result (Dependent Variable: Log of the change rate in housing units per developed area between 2001 and 2006)

Variable	Model 1		Model 2	
	Estimated Coefficient	Standard Error	Estimated Coefficient	Standard Error
C (Intercept)	0.361 *	0.197	0.355 *	0.186
ln(DLR01)	0.005	0.005	-0.002	0.005
ln(OWNR01)	0.057 **	0.027	0.030	0.027
ln(PCI01)	-0.033 *	0.019	-0.034 *	0.018
ln(MHVPCI01)			-0.015	0.016
ln(PGR9101)	0.264 ****	0.026	0.277 ****	0.027
ln(OLDHUGR)	-0.038 **	0.018	-0.040 **	0.017
ln(PCIGR)	0.139 ***	0.049	0.129 ***	0.046
ln(MHVPCICHR)			0.107 ****	0.021
CENTRAL	0.014	0.009	0.015 *	0.008
SUBMSA	0.008	0.008	0.007	0.008
GM	0.026 ****	0.007	0.011	0.008
GMWRLURI	-0.020 **	0.008	-0.020 **	0.008
WRLURI	0.002	0.005	-0.003	0.005
R-squared	0.534		0.586	
Adjusted R-squared	0.509		0.559	

**** 0.1% level Significant | *** 1% level Significant | ** 5% level Significant | * 10% level Significant



Data source:
Annual Statistics, Housing Vacancies and Homeownership Survey, U.S. Census

Figure 1. Vacancy Rate Change in the U.S.

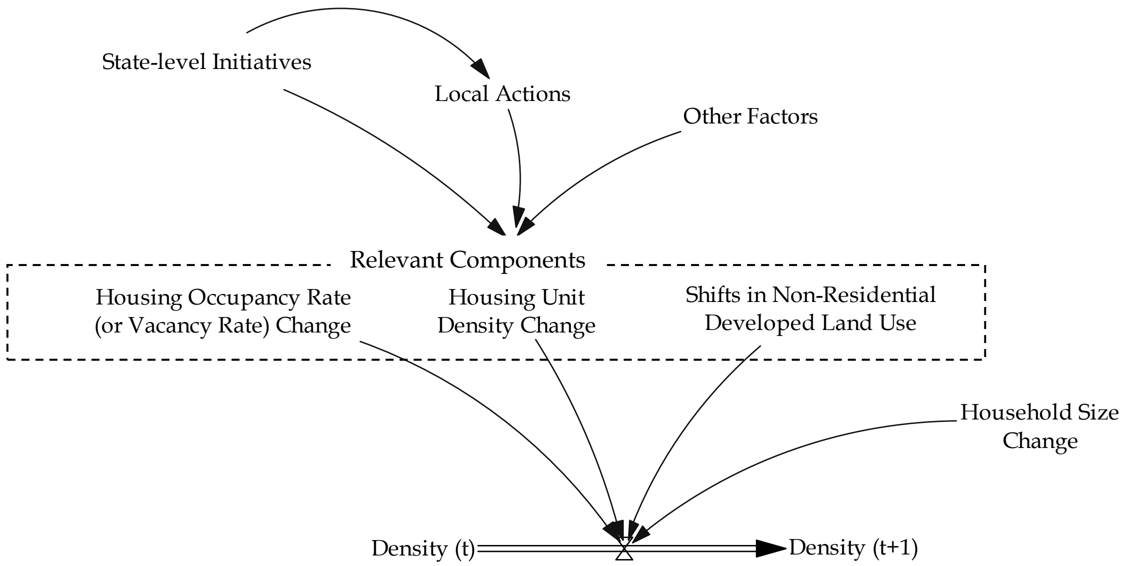


Figure 2. Analytical Framework