U.S. Micropolitan Area Growth: A Spatial Equilibrium Growth Analysis

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Abstract. Because micropolitan areas have only relatively recently been defined, little is known about their comparative economic performance. Part of the interest in micropolitan areas stems from the successful ones often growing to become metropolitan areas. This paper examines micropolitan area growth during the 1990s, a period of strong national growth. A spatial equilibrium growth framework and estimated reduced-form regressions containing an extensive number of variables are used to assess the sources of differentials in micropolitan area growth. To varying degrees, at various levels, and through various channels, it is found that household amenity attractiveness, firm location considerations, and housing supply policies, all underlie micropolitan area growth differentials.

1. Introduction

The 1990's was a period of economic prosperity in the U.S., containing the longest economic expansion in history. This period also marked the beginning of the "new economy" with advances in internet, information, telecommunications and other production technologies. Population grew 13.2 percent over the decade, with 14 percent growth occurring in the metropolitan portion of the country, 10 percent in micropolitan areas and 7.8 percent in the remaining rural areas (Mackun, 2005). Among metropolitan areas, fastest growth occurred in those containing between 2.5 and 5 million people (16.2 percent), while slowest growth occurred in those containing between fifty and one hundred thousand people (9 percent). Also, the larger the micropolitan area the faster was its growth. In an analysis of U.S. county population growth, Partridge et al. (2008b) found that a nonmetropolitan county grew faster the closer it was to large metropolitan areas.

As a recently created construct, micropolitan areas have been studied much less extensively than metropolitan areas or nonmetropolitan areas more broadly. A micropolitan area is roughly defined as counties that contain a city with population between ten and fifty thousand or have tight commuting links to such a city. Thus, they are small urban areas, likely to have different growth dynamics than either metropolitan or rural areas. When first officially created using the 2000 Census, there were 674 micropolitan counties, comprising approximately ten percent of the U.S. population (U.S. Office of Management and Budget, 2003).

During the 1990s, population increased much faster in micropolitan areas located in the west and south, in which the center of gravity for the micropolitan population steadily drifted from the northeast to the southwest, suggesting amenity-based migration and growth (Mulligan and Vias, 2006). This result follows the general pattern found for metropolitan and nonmetropolitan counties more broadly (Deller, 2001; Partridge et al., 2012). Plane et al (2005) found that there was substantial migration in the latter parts of the 1990's by people in the 50-64 age group from large metropolitan areas to micropolitan and rural areas, which may have been motivated by quality-of-life considerations. Partridge et al. (2010) also found nonmetropolitan counties to increasingly be attractive to households the further they were from larger metropolitan counties, though remoteness was increasingly relatively less productive. In an analysis of metropolitan areas, Glaeser and Tobio (2008) suggest that strong population growth in the South was more attributable to pro-growth housing regulations than climate.

Therefore, the purpose of this study is to analyze U.S. micropolitan area population growth to better understand whether variation in growth among micropolitan areas mostly derived from variation in household amenity attractiveness, firm location attributes, or in regulations affecting housing supply. We examine the decade of the 1990s, the decade immediately preceding the definition of micropolitan areas, and a period of robust growth. The most recent decade not only contained the Great Recession, it also contained a housing bubble that affected growth dynamics (Mian and Sufi, 2009). The 1990s more likely reflected the long-run determinants of growth in micropolitan areas.[1]

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[1]For example, Partridge et al. (2012) report that some of the long-run growth patterns in metropolitan and nonmetropolitan counties in the last half of the twentieth century weakened somewhat during the 2000-2007 period.

To disentangle the sources of micropolitan area growth we use the spatial equilibrium growth framework of Glaeser and Tobio (2008). The approach consists of estimating reduced-form equations of population growth, wage growth and housing rent growth. An extensive number of variables, which have been found to be important growth determinants generally, are included in each regression. The structural equations of the Glaeser and Tobio (GT) model are then used to disentangle the estimated reduced-form coefficients and identify the relative contributions of the three broad sources of growth. The most important variable groups and individual variables also are identified. Finally, we examine the residuals of the estimated reduced form equations to determine whether the unaccounted for portions of population growth derive more from household, firm, or housing supply considerations.

Among the primary findings, based on general dominance variance analysis, we find industry composition to be the most important source of variation in micropolitan area population growth. The group of Census division dummy variables is found to be the second most influence on population growth. Based on the patterns of Census division coefficients in the three regressions, differences in productivity growth primarily underlie the Census division effects, particularly for the Mountain and Pacific states, which also were found to have the most restrictive housing supply policies. The coefficients also were consistent with differentials in Census division household amenity attractiveness, but to a lesser extent. The single most important population growth variable though in terms of per standard deviation impact was the average January temperature. The third most influential group of variables on population growth was state and local policy variables, in which county spending on education and highways spurred growth, while a negative effect was found for state income taxes. Other variables having large individual impacts included the distance of a micropolitan area from the nearest metropolitan area and the incremental distance to a metropolitan area greater than 250 thousand in population, suggesting that remoteness reduced growth.

2. Growth Model

We use the spatial growth model of Glaeser and Tobio (GT) (2008), which they used to examine the sources of growth in the U.S. South. Rickman and Rickman (2011) used the model to examine the potential changing role of natural amenities in U.S. nonmetropolitan county growth. The presentation of the model below follows that of the two studies.

The GT approach borrows from the spatial equilibrium framework of Haurin (1980) and Roback (1982). The primary difference is the translation of spatial equilibrium into a growth context and incorporation of a housing supply shifter that represents differences in housing supply regulations. Hence, in addition to reflecting household amenity attractiveness, housing prices also reflect the effects of housing supply polices

First, the approach specifies regional production as Cobb-Douglas:

$$Y = AN^{\beta}K^{\gamma}Z^{1-\beta-\gamma}, \tag{1}$$

where A is a productivity shifter, N is the number of workers (and population, assuming full employment), K is traded capital and Z is nontraded capital (e.g., infrastructure and natural capital). Profit maximization implies the following inverse labor demand function:

$$W = \beta\gamma^{\gamma/(1-\gamma)} A^{1/(1-\gamma)} N^{(\beta+\gamma-1)/(1-\gamma)} Z^{(1-\beta-\gamma)/(1-\gamma)}, \tag{2}$$

in which W denotes the wage rate, γ is the input share of mobile capital, and β is the labor input share.

Regional households derive utility from the consumption of a numeraire traded good C and non-traded housing H:

$$U = \phi C^{1-\alpha} H^{\alpha}, \tag{3}$$

where ϕ represents a utility shifter, which captures the amenity attractiveness of the area, and α is the housing expenditure share. Utility maximization yields the following indirect utility function, in which utility is equalized across regions:

$$V = \phi W Ph^{-\alpha} \alpha^{\alpha} (1-\alpha)^{(1-\alpha)}, \tag{4}$$

where Ph is the price of housing.

The supply of housing (H) is given by the fixed level of land (L) at cost P_L per unit of land and housing structure (h) on the land at cost, ξh^{δ}, where ξ is a constant with a value greater than one. Free entry in housing development produces zero economic profits in equilibrium and the price of housing endogenously adjusts to clear the housing market. Using the first order profit maximizing level of *h*, total housing supply is given as:

$$hL = (Ph/\xi\delta)^{(1/(\delta-1))}. \quad (5)$$

Equating housing demand with housing supply in equilibrium yields the following expression for housing prices:

$$Ph = (\delta\xi)^{(1/\delta)}((N/L)\alpha W)^{((\delta-1)/\delta)} . \quad (6)$$

Taking the natural logs of the labor demand function, the indirect utility function, and the inverse housing supply function, and solving them simultaneously for equilibrium produces the static equilibrium equations:

$$\log N = K_N + \left\{ \frac{(\delta+\alpha-\delta\alpha)Log(A) + (1-\gamma)(\delta Log(\phi) + \alpha(\delta-1)\log(L)}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))} \right\} \quad (7)$$

$$\log W = K_W + \left\{ \frac{(\delta-1)\alpha Log(A) - (1-\beta-\gamma)(\delta Log(\phi) + \alpha(\delta-1)\log(L)}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))} \right\} \quad (8)$$

$$\log Ph = K_P + \left\{ \frac{(\delta-1)Log(A) + \beta Log(\phi) - (1-\beta-\gamma)\log(L)}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))} \right\} \quad (9)$$

A growth dimension is incorporated by adding unanticipated shocks to (innovations in) productivity, amenity attractiveness, and housing supply. The shocks/innovations arise either from changes in locational characteristics or of their importance. The absence of such changes would produce a spatially-balanced growth path (Partridge et al., 2008a). The change in each from some period *t* to *t* + 1 consists of a common component to all areas (*K*), a component specific to variable S (λ) and an idiosyncratic component (μ):

$$\log\left\{\frac{A_{t+1}}{A_t}\right\} = K_A + \lambda_A S + \mu_A \tag{10}$$

$$\log\left\{\frac{\phi_{t+1}}{\phi_t}\right\} = K_\phi + \lambda_\phi S + \mu_{A\phi} \tag{11}$$

$$\log\left\{\frac{L_{t+1}}{L_t}\right\} = K_L + \lambda_L S + \mu_L \,. \tag{12}$$

The static equilibrium Equations (7)–(9) are converted into growth equations by assuming that they hold at all points in time (Dumais, Ellison, and Glaeser, 2002), while substituting in the expressions from Equations (10)–(12):

$$\log\left\{\frac{N_{t+1}}{N_t}\right\} = \acute{K}_N + \left\{\frac{(\delta+\alpha-\delta\alpha)\lambda_A S + (1-\gamma)\delta\lambda_\phi S + (1-\gamma)\alpha(\delta-1)\lambda_L S}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))}\right\} + \mu_N \tag{13}$$

$$\log\left\{\frac{W_{t+1}}{W_t}\right\} = \acute{K}_W + \left\{\frac{(\delta-1)\alpha\lambda_A S + (1-\beta-\gamma)\delta\lambda_\phi S + (1-\beta-\gamma)\alpha(\delta-1)\lambda_L S}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))}\right\} + \mu_W \tag{14}$$

$$\log\left\{\frac{Ph_{t+1}}{Ph_t}\right\} = \acute{K}_{Ph} + \left\{\frac{(\delta-1)\lambda_A S + (\delta-1)\beta\lambda_\phi S - (\delta-1)(1-\beta-\gamma)\lambda_L S}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))}\right\} + \mu_{Ph} \,. \tag{15}$$

Rather than represent Sunbelt status of U.S. metropolitan areas as in Glaeser and Tobio (2008) or the natural amenity ranking of a U.S. nonmetropolitan county as in Rickman and Rickman (2011), S represents the X variables in the reduced form regressions for U.S. micropolitan areas. Ḱ represents the constant, while the terms in the brackets correspond to the estimated reduced-form coefficients on the independent variables and μ are the estimated reduced-form residuals.

We write the estimated reduced-form regression vectors of coefficients on the S variables as:

$$b_N = \frac{(\delta+\alpha-\delta\alpha)\lambda_A + (1-\gamma)\delta\lambda_\phi + (1-\gamma)\alpha(\delta-1)\lambda_L}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))} \tag{16}$$

$$b_W = \frac{(\delta-1)\alpha\lambda_A + (1-\beta-\gamma)\delta\lambda_\phi + (1-\beta-\gamma)\alpha(\delta-1)\lambda_L}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))} \tag{17}$$

$$b_{Ph} = \frac{(\delta-1)\lambda_A + (\delta-1)\beta\lambda_\phi - (\delta-1)(1-\beta-\gamma)\lambda_L}{(\delta(1-\beta-\gamma)+\alpha\beta(\delta-1))} \quad . \tag{18}$$

Using these expressions and the estimated reduced-form coefficients we can solve for the vectors of shocks/innovations in household amenities, productivity and housing supply as:

$$\lambda_A = (1-\beta-\gamma)b_N + (1-\gamma)b_W \tag{19}$$

$$\lambda_\phi = \alpha b_{Ph} - b_W \tag{20}$$

$$\lambda_L = b_N + b_W - \left(\frac{\delta b_{Ph}}{\delta - 1}\right) \quad . \tag{21}$$

where positive values in Equations (19)-(21) lead to population growth through multiplier effects in Equation (13) (Glaeser and Tobio, 2008).

Because we also are interested in whether the residuals reveal anything about the sources of unexplained population growth we use the expressions for the coefficients in Equations (19)-(21), except substituting the estimated residuals in the equations in place of the estimated reduced-form coefficients:

$$\lambda_A^U = (1-\beta-\gamma)\mu_N + (1-\gamma)\mu_W \tag{22}$$

$$\lambda_\phi^U = \alpha\mu_{Ph} - \mu_W \tag{23}$$

$$\lambda_L^U = \mu_N + \mu_W - \left(\frac{\delta\mu_{Ph}}{\delta - 1}\right). \tag{24}$$

The expressions reveal whether the sources of unexplained growth relate more to productivity, household amenities, or housing supply considerations.

3. Empirical Model

Following from above, three hedonic cross-sectional growth regressions are estimated for the 1990 to 2000 period. With the exceptions of lagged levels of the dependent variables, each equation contains the same independent variables. To avoid direct endogeneity, most variables are measured at or near the beginning of the period.

To capture broad fixed effects (Glaeser and Tobio, 2008), Census division dummy variables are included (**CENSUS**). We include variables measuring natural amenities (**AMEN**) related to climate, topographic variation and water coverage, which have consistently been found to be associated with growth generally in the United States (McGranahan, 1999; Deller et al., 2001; Rickman and Rickman, 2011; Partridge et al., 2012). Several variables reflecting the position in the urban hierarchy (**GEOG**) are included as they have been shown to be associated with nonmetropolitan growth during the 1990s (Partridge et al., 2008a; 2008b).

To control for state and local policy effects on growth, which have been found to significantly influence nonmetropolitan area wage and housing rent growth (Yu and Rickman, forthcoming), a vector of variables related to state and county taxes and expenditures are included, along with a variable denoting whether a micropolitan area was located in a state possessing a right-to-work law (**POLICY**). Given their importance in explaining growth generally (Glaeser et al., 1995), we include variables reflecting educational attainment and opportunities (**EDUC**). Demographic variables (**DEMOG**) related to ethnicity, age and family structure also are included. Finally, we control for the influence of industry structure (**IND**).

Therefore, the three reduced-form equations can be written as:

$$\mathbf{POPGRW}_i = f(\mathbf{DEN}_i, \mathbf{AMEN}_i, \mathbf{CENSUS}_i, \mathbf{GEOG}_i, \mathbf{POLICY}_i, \mathbf{EDUC}_i, \mathbf{DEMOG}_i, \mathbf{IND}_i) \quad (25)$$

$$\mathbf{WGRW}_i = g(\mathbf{WLAG}_i, \mathbf{AMEN}_i, \mathbf{CENSUS}_i, \mathbf{GEOG}_i, \mathbf{POLICY}_i, \mathbf{EDUC}_i, \mathbf{DEMOG}_i, \mathbf{IND}_i) \quad (26)$$

$$\mathbf{RGRW}_i = h(\mathbf{RLAG}_i, \mathbf{AMEN}_i, \mathbf{CENSUS}_i, \mathbf{GEOG}_i, \mathbf{POLICY}_i, \mathbf{EDUC}_i, \mathbf{DEMOG}_i, \mathbf{IND}_i) \quad (27)$$

where **POPGRW**, **WGRW** and **RGRW** denote the rate of population, wage, and housing rent growth from 1990 to 2000, respectively; **DEN** denotes population density in 1990; **WLAG** is the 1990 wage rate level; **RLAG** is the 1990 level of housing rent; and *i* denotes micropolitan area.

4. Empirical Implementation

Micropolitan areas, as defined by the U.S. Office of Management and Budget (2003), located in the 48 contiguous continental states are used in the analysis. Thus, the analysis begins with 554 micropolitan areas that encompass 662 counties in the lower 48 states. Data at the county level are aggregated (population-weighted) into the micropolitan area definitions. Variable descriptions, sources and descriptive statistics appear in Table 1.

4.1 Variables and Data

Following Partridge et al. (2010), Rickman and Rickman (2011) and Yu and Rickman (forthcoming), the median gross rent used to construct **RGRW** and **RLAG** is from the Census of Population for 1990 and 2000. Median growth rent is constructed as a weighted average of the median gross monthly rent for rental housing and imputed rent for owner occupied housing, with the shares of renter and owner occupied houses used as the weights. The median gross rent for rental housing is defined as contract rent plus the estimated average monthly cost of utilities. The median imputed rent for owner occupied housing is calculated by converting the median value of owner occupied housing (complete count) using a discount rate of 7.85% (Peiser and Smith, 1985). The median gross rent does not control for differences in housing quality between regions, though this has not been found to affect estimates of county growth determinants (Rickman and Rickman, 2011), and can introduce endogeneity. Population likewise, is from the Census of Population for 1990 and 2000. Wage rates used to calculate, **WGRW** and **WLAG**, are obtained by dividing private non-farm payroll by private non-farm employment.

CENSUS includes dummy variables for Census divisions 2-9. **AMEN** includes USDA Economic Research Service's measures of natural amenities: average January and July temperatures, average July humidity, water area and topographic variation (typography). **DEMOG** includes births per 1000 population, percent of married households, population percentages of African, Hispanic and Asian Americans; and the percent of people in the 25-49, 50-64 and 65 plus age groups, all from the Census of Population 1990. **EDUC** includes percent of the adult population aged 25 years and older with a high school degree, the percent with a four year college degree or higher, and the presence of a land-grant university.

POLICY includes numerous regional tax and expenditure variables expressed as a share of personal income for the county or state: county and state property and sales taxes, county and state government spending on highway and safety, county spending on education, state spending on health and hospitals, state personal and corporation income taxes, and whether the micropolitan area's state has a right-to-work law, all from Yu and Rickman (forthcoming). **IND** includes: percent jobs in farming (agricultural, forestry and fishing services); mining, construction, manufacturing, services, government. It also includes the unemployment rate to control for differing beginning period levels of slackness in the labor market.

GEOG includes the distance of the micropolitan area to the nearest metropolitan area (MA), measured between the population-weighted centroids of the areas. It also includes the incremental distances to more populous higher tiered urban centers to capture the incremental or marginal costs on growth to reach each higher-tiered (larger) urban center: the incremental (additional) distances to reach MAs of at least 250 thousand, 500 thousand, and 1.5 million people. The largest category generally corresponds to national and top-tier regional centers, with the 500 thousand-1.5 million population category reflecting sub-regional tiers (Partridge et al., 2008a; 2008b; 2010).[2]

4.2 Econometric Issues

Each regression is estimated using OLS and White's correction to the variance-covariance matrix for heteroscedasticity. Because the counties are aggregated into micropolitan areas, which are distributed widely with rural and metropolitan counties in between, spatial

[2] For example, if a micropolitan county is 50kilometers from the nearest metropolitan area, which has less than 250 thousand people, and 100 kilometers from the nearest metropolitan area with more than 250 thousand people, the incremental distance to the nearest MA over 250 thousand is 50 kilometers. Using actual distances rather than incremental distances has not been found to affect growth regression results, only resulting in somewhat greater multicollinearity (Partridge et al., 2008a; 2008b).

autocorrelation is not considered. The influence of metropolitan areas on micropolitan areas is accounted for by the distance variables in the GEOG vector.[3]

Analysis of the raw data revealed significant variation in the data for the independent variables and the existence of potential outliers that might have undue influence on the estimated regression results. Because we mostly are interested in addressing the growth determinants for the typical micropolitan area, we purged the areas from our sample with disproportionate values of the independent variables using the method of the Hat Matrix. The Hat Matrix is defined as

$$h = (x^T x)^{-1} x^T,$$

where the disproportionate X variables are purged based on leverage analysis of the diagonal of the matrix (Belsley, Kuh, and Welsch, 1980).

We also used the method of k-means clustering to identify outliers of micropolitan growth in the dependent variables. The k-means clustering method allocates the data points into a set into k clusters, minimizing the Euclidean distance between the average in the cluster (cluster center) and each point in the cluster.[4] The FASTCLUS procedure in SAS was used to perform a five centroid cluster analysis and micropolitan areas with extreme above and below growth performance in the dependent variables were identified for each dependent variable. Most of the outliers identified by this procedure corresponded to outliers that were identified by the Hat Matrix method.

We began the analysis with 554 micropolitan areas. The Hat Matrix method resulted in the purging of 40 observations, with three additional areas purged due to extreme outliers

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[3] Consistent with the literature (Partridge et al. 2010, 2012; Rickman and Rickman 2011; LeSage and Dominguez 2012), we do not include metropolitan or rural counties in the sample to account for spatial spillovers because by definition metropolitan and rural areas are separate functional economic regions with likely differing growth dynamics from micropolitan areas. Also, even if slope shifters are specified for rural and metropolitan counties to allow for differing dynamics in a common sample, any spillovers between these counties and micropolitan areas likely differ from each other; i.e., homogenous spillover effects would be assumed in spatial econometric estimation despite assuming differing growth dynamics with the use of slope shifters (Yu and Rickman, forthcoming). In addition, we do not estimate a spatial lag model because Gibbons and Overman (2012) show how a model with a spatial lag of X (e.g., our distance variables) is virtually observationally equivalent with a spatial lag of the dependent variable, in which the former has ready interpretation.

[4] http://support.sas.com/documentation/cdl/en/statugcluster/61777/PDF/default/statugcluster.pdf

identified by cluster analysis. This left 511 micropolitan areas for the regression analysis. The purging of outliers resulted in a reduction of total variance of 25.2 percent in population growth, 9.1 percent in housing rent growth, and 20.3 percent in wage growth. Nevertheless, the data still show significant variation in the dependent variables: population growth ranges from negative 17.1 percent to positive 73.6 percent during the period; -2.8 percent to 133.7 percent for housing rents; and -2.9 percent to 97.9 percent for wages (Table 1).

5. Results

Table 2 contains the regression results for the reduced-form equations. All three regressions are statistically significant. The population growth regression has an R^2 of 55.8 percent, in which twenty three variables are significant at the 5 percent level and an additional three at the 10 percent level. The housing rent growth regression has an R^2 of 71.8 percent, with twenty nine of the variables significant at the 5 percent level and an additional 3 significant at the 10 percent level. Nineteen of the significant variables in the housing rent equation also are significant in the population growth regression, with all but one having the same sign in both regressions. The wage growth regression has an R^2 of 39.2 percent, in which twelve variables are significant at the 5 percent level and an additional 5 variables are significant at the 10 percent level. Six of the significant variables also are significant in the population and the rent regressions.

It generally could be expected that variables positively influencing housing rent also positively influence population growth. For example, greater amenity attractiveness of an area attracts more households and increases housing rents. However, while more firms increase nominal wages, more households may not affect the nominal wage rate, and may even have a depressive effect. Thus, wage rates and population growth less likely move in tandem, depending on whether the firm or household effect is greater in the area (Partridge and Rickman, 1999; Partridge et al., 2010).

5.1 Interpretation of the Estimates

The natural amenity variables generally have their expected effects. Increased natural amenity attractiveness significantly increases popualtion growth (four of the five variables), significantly increases housing rent growth (two of the five variables) and significanlty reduces wage rate growth (two of the five variables). Among the three regressions, only water coverage has an unexpected sign in the wage regression. The variables raising housing rents and reducing (or not affecting) nominal wages fit the pattern of greater household amenity attractiveness as revealed by Equation (20).[5]

Among the geography variables, greater distance from any metropolitan area and the incremental distance from a metropolitan area greater than 250 thousand in population significantly reduced population growth. These two variables, along with the incremental distance to a metropolitan area with more than 500 thousand people reduced housing rent growth. Except for the distance to the nearest metropolitan area, all distance variables significantly reduced wage growth.

Thus, the weaker growth in population and wages according to Equation (19) reveals increasing productivity disadvantages the more remote the micropolitan area in the urban hierarchy, consistent with the findings of Partridge et al. (2010). The slower growth in housing rents is sufficient to cause Equation (21) (not shown) to indicate that remoteness from metropolitan areas (except from the largest areas) also was associated with more favorable housing regulatory environments, particularly for greater distance from any metropolitan area.

Industry composition significantly influenced population growth. Larger initial shares of payroll employment in agricultural services, mining and manufacturing were associated with slower population growth over the decade. A larger initial share of farm employment was associated with faster population growth. A similar pattern is apparent for housing rent growth. Wage growth was stronger for initial shares of construction and manufacturing.

[5] The following coefficient values from Rickman and Rickman (2011) are used in the equation calculations: the housing expenditure share, α=0.23; the mobile capital share in production, γ=0.3; the labor share in production, β=0.6; while δ=1.5.

It could be expected that the primary influence of industry composition would occur through growth-promoting firm productivity effects (Partridge and Rickman, 1999; 2003). But the negative population growth effect of manufacturing suggests that it did not experience productivity led expansion. Wages can increase in manufacturing even when employment declines if the most productive workers are retained or technological innovation is spurred in the face of negative demand shocks such as those arising from increased exposure to international trade (Autor et al., 2011). Yet, when also considering the significantly negative effect on housing rents, greater employment concentration in manufacturing also may be a household disamenity, possible associated with greater area pollution. The negative effect on population growth and housing rents, along with the insignificant wage effects suggests that greater employment concentration in mining also may reduce household amenity attractiveness of the area. Combined with the significant wage effect, the nearly significant positive effect on population for the construction employment share suggests a productivity role for the variable.

Among the education variables, only the percent of the population with a four-year college degree or higher was associated with faster growth, being statistically significant in each equation. From Equation (19), this suggests the variable as strongly reflecting increasing productivity advantages. Having a land grant university was insigificant, suggesting that besides potentially supplying human capital in the area, it did not spur micropolitan area growth.

Regarding the county fiscal variables, county spending on highways and education was significantly associated with stronger population and housing rent growth. The positive effects on population growth, absence of a wage effect and positive effects on housing rents suggests that county spending on highways and education increased household amenity attractiveness of the area (Equation 20), while it also increased productivity (Equation 19). County spending on safety had a negative effect on population growth, while county sales taxes had a positive effect on housing rent growth. No significant county fiscal effects were found for wages.

State income taxes and spending on hospitals negatively affected population growth. Significantly negative effects on housing rent growth also were found for state sales taxes and state spending on public safety. Combined with the absence of wage effects, the negative housing rent effects suggest state income taxes and spending on public safety adversely affect the amenity attractiveness of the area. Having a state right-to-work law only (positively) affected housing rent growth. A significant negative effect on wage growth occurred for state spending on highways; when combined with the insignificant effect on housing rents, this suggests a positive household amenity effect according to Equation (20), consistent with the evidence for nonmetropolitan counties generally reported by Yu and Rickman (forthcoming).

The Census divison dummy variables are mostly individually significant in the population and housing rent growth equations. Only the variables for Census Divisions 8 and 9 are significant in the wage equation. Use of Equations (19)-(21) and the statistically significant coefficients from the three regressions reveals the sources of the differences. The λ's calculated from these equations can then be used with Equation (13) to determine which source had the largest effect on population growth.

Notable results (not shown) include the strongest productivity growth in Census Divisions 8 and 9–the Mountain and Pacific states–combined with the most restrictive housing supply policies. Restrictive housing supply policies and strong productivity growth boosted wages and housing prices, but limited population growth. All Census divisions have more pro-growth housing supply policies than the omitted category, Division 1 (the New England states).

The estimates also reflect differences in natural amenities, particularly for the South Atlantic states, consistent with studies that have found amenities to primarily be capitalized into land/housing prices rather than wages (Wu and Gopinath, 2008; Rickman and Rickman, 2011). Yet, the standard deviation of the estimated population growth of the three sources reveal productivity growth as the dominance source, followed next by natural amenities and then housing supply policies. However, with other natural amenity variables included, the Census division dummy variables simply may capture unmeasured natural amenity attributes. Perhaps also, the firm productivity growth relates to natural amenities as they have been shown to attract human capital (e.g., creative class members) by McGranahan and Wojan (2007), and may attract footloose firms with owners who wish to live a high amenity location.

5.2 Variance Analysis

Consistent with the analysis of Ferguson et al. (2007) for Canadian communities, to assess which groups of variables most explain the variation in population, housing rent, and wage growth we perform a general dominance analysis. A predictor is said to generally dominate another predictor when it has a higher average additional contribution to the R^2 among all combinations of predictors (Azen and Budescu, 2003). With seven variable groups there are $(2^7-1) = 127$ possible different statistical combinations possible for the variable group regressions, which are the base regressions that have to be run for comparison. There are 63 additional regressions that have to be run for each group to find out the additional contributions to the R^2 when the respective variable group is added to the base regressions, or a total 441 additional contribution regressions. Therefore, a total of 1,704 regressions were run for all three models (population, wages and rent) to establish general dominance analysis.[6]

The average contributions to explaining population, housing rent and wage rate growth by the different variable groups are shown in Tables 3-5. The Census division variables explained over forty percent of housing rent growth, very little of wage growth and about twenty percent of population growth. Based on the discussion of the signs of the coefficients above, this suggests that Census division differences in productivity, followed by differences in amenity attractiveness, were primary drivers of micropolitan area performance during the 1990s.

Aside from the Census division dummy variables, industry composition explained the most variation of all three variables: 16.5 percent of the variation in housing rent growth, 22.2 percent of variation in population growth and 77.4 percent of wage growth. Per the discussion

[6] We used the adjusted R^2 for the general dominance analysis rather than R^2. The adjusted R^2 is preferable for decomposition when there are many variables and different numbers of variables in some groups between the models that are being compared. The sample adjusted R^2 also is a better estimate of the population R^2 (Wooldridge, 2005 p. 2007).

above, given the expected relationship between wages and productivity (Partridge and Rickman, 1999; 2003), most of the influence of industry composition most likely worked through productivity, though there also could have been amenity effects through manufacturing and mining.

The next most important variable groups for population growth were the policy and demographic variables. The two groups of variables were important in explaining housing rent growth but not wage growth. Natural amenities were more important in explaining housing rent growth though than the demographic and policy variables. Recall that with Census division dummy variables included, the measures of natural amenities only reflect the influence of their within division variation. The education and geography variables generally explained the least amount of variance in micropolitan area growth.

Next, beta coefficients from the 64 combinations (from regressions of a given variable group by itself plus the 63 additional contributions of that variable group in all possible combinations with the other variable groups) for each variable for all three regressions were averaged to get the standardized impact from each variable within each group in order indicate the relative importance of the respective variable within the group. The results for the statistically significant variables in each regression are displayed in Tables 6-8.

The absolute value size of the average standardized beta coefficients shows that the largest per standard deviation influence on population growth was the average temperature in January, which was followed by the Census Division 5 dummy variable. In terms of industry composition, the most influential variable group for population growth, the influence primarily occurred through area concentration of employment in the mining and manufacturing industries (given their large standard deviations shown in Table 1). The negative policy differences appeared to be more important than the variables positively associated with population growth in terms of the per standard deviation impact.

Consistent with the variance dominance analysis, the Census division variables all have the largest impact on housing rent growth. Aside from the beginning period level of housing rent, the next largest impact occurs from the negative effect of a hotter July. Large negative effects also occur for greater distances from areas further up in the urban hierarchy.

Aside from the beginning period wage rate, the largest (absolute value) beta coefficient in the wage growth regression is for the average January temperature, while the average July temperature beta coefficient is the fifth largest. The second largest coefficient is for the Census Division 8 dummy variable. Other notable variables include: the initial employment share in manufacturing; the share of the adult population possessing a four year college degree or higher; and the initial share of employment in construction.

5.3 Analysis of Regression Residuals

The final step of the analysis is to examine the residuals for patterns that suggest whether the influences on growth omitted from the regressions derive primarily from factors related to household amenity attractiveness, firm productivity, or housing supply. We first substitute the reduced-form residuals into Equations (22)-(24). Then we compute correlaton coefficients between these results and residual population growth. For example, if residual population growth is strongly correlated with residual wage growth, we would conclude that there were sizable omitted productivity influences on growth. If instead, residual population growth were more negative correlated with real wage residuals (Equation 23), we would conclude there were mostly omitted natural amenity influences on growth.

As shown in Table 9, residual population growth best fits a patterns of unexplained productivty-based growth, though the correlation coefficient is modest. This is followed by unexplained natural amenity-based growth. Unexplained housing supply growth is negatively correlated, suggesting an absence of unexplained factors, or that they are dominated by the other influences.

6. Summary and Conclusion

This study examined the determinants of variation in micropolitan area growth during the 1990s. Using the spatial growth framework of Glaeser and Tobio (2008), the study assessed the influence of factors related to household amenities, firm productivity and housing supply.

Both patterns in regression coefficients and residuals from estimated reduced-form regressions for population growth, housing rent growth and wage growth are examined in the assessment.

As a group, the area's industry composition was the most important source of variation in micropolitan area population growth. Stronger growth was associated with larger employment shares in farming and smaller shares in agricultural and forestry and fishery services, manufacturing, and mining. There was a negative significant effect on wages for agricultural and forestry and fishery services, suggesting adverse productivity effects. Significant negative effects on housing rents were found for mining and manufacturing and a positive wage effect for manufacturing, suggesting that larger employment shares in these industries negatively affected household amenity attractiveness. The manufacturing result, however, may have in part been the result of adjustments by firms to international trade shocks (Autor et al., 2011).

Census division dummy variables had the second largest contribution to the adjusted r-squared for population growth. Based on the patterns of Census division coefficients in the three regressions, differences in productivity primarily underlied the Census division effects, particularly for the Mountain and Pacific states, which also had the most restrictive housing policies. The coefficients also were consistent with differentials in Census division household amenity attractiveness, but to a lesser extent. Nevertheless, the single most important populaton growth variable in terms of per standard deviation impact was the average January temperature. In contrast to the findings by Glaeser and Tobio (2008) for metropolitan areas in the Sunbelt, housing supply policies had the least influence of the three sources.

The third most influential group of variables on population growth were state and local policy variables. Among these variables, the largest positive effects were from county spending on education and highways, which were interpreted as both positively influencing the household amenity attractiveness and productivity of the area. The only significant negative tax effect was from state income taxes.

Other variables having large individual impacts included the distance of a micropolitan area from the nearest metropolitan area and the incremental distance to a metropolitan area greater than 250 thousand in population. Combined with the significant influence of these two variables on wage growth, this reveals increasing productivity disadvantages of remote micropolitan areas, consistent with the evidence of Partridge et al. (2010) for nonmetropolitan areas. The variables, along with the incremental distance to a metropolitan area with more than 500 thousand people, significantly reduced housing rent growth as well, suggesting more pro-growth housing supply policies in remote areas, a factor not considered in previous studies.

Therefore, although we do not confirm the findings of Glaeser and Tobio (2008) regarding the dominance of pro-growth housing policies for growth in the U.S. South, we confirm their importance in assessing growth differences generally. Despite increasing productivity disadvantages in more remote areas, capitalizing on amenity attractiveness, and pro-growth housing supply policies, are policy options in remote areas. Yet, as suggested in Rickman and Rickman (2011), areas rich in natural amenites need to exercise caution in promoting growth because of potential adverse growth impacts on the quality of life.

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Table 1.
Description of Data and Data Groups

Dependent Variables	Obs	Mean	Std Dev	Min	Max	Data Source
Population 90-00	511	9.3	11.2	-17.1	73.6	US Census
Medan Rent 90-00	511	54.6	19.2	-2.8	133.7	US Census
Avg. Wages 90-00	511	40.7	11.1	-2.9	97.9	US Census
Lagged Variables						
Population Density 1990	511	62.38	41.68	1.787	265.301	US Census
Median Rent 1990	511	325.60	86.99	176.915	906.013	US Census
Average Wages 1990	511	16.88	2.38	10.4361	29.0493	US Census
Amenity Variables	**Obs**	**Mean**	**Std Dev**	**Min**	**Max**	**Data Source**
Humidity	*511*	57.10	13.69	18	79	USDA
Land Surface Form Typography codes:	511	8.49	6.67	1	21	USDA
Mean January Temperature	511	33.08	11.69	3.1	63.4	USDA
Mean July Temperature	511	75.79	5.38	55.9	86.7	USDA
Water Sq. Miles	511	3.87	8.95	0.01	66.13	USA Counties Program: US Census
Demographic Variables	**Obs**	**Mean**	**Std Dev**	**Min**	**Max**	**Data Source**
Births per 1,000 population 1990	511	14.88	2.40	9.1	26.4	US Census
Percent African American 1990	511	8.71	13.87	0	64.6	US Census
Percent Asian American 1990	511	0.52	0.48	0.04	3.57	US Census
Percent Hispanic American 1990	511	4.31	10.94	0.2	84.4	US Census
Percent of Married Households 1990	511	59.39	4.68	42.5	73.3	US Census
Percent of Population in over 65 or Older 1990	511	14.51	2.88	5.1347	31.3137	US Census
Percent of Population in the 25-49 Age Group 1990	511	34.51	2.35	26.1	46.7	US Census

Percent of Population in the 50-64 Age Group 1990	511	13.66	1.57	7.8099	20.9226	US Census
Educational attainment - persons 25 years and over - Bachelor's, Master's, or Professional degree 1990	511	13.27	4.50	5.5	36.3	US Census
Educational attainment - persons 25 years and over - percent high school graduate or higher 1990	511	69.75	8.68	42.9	89.1	US Census
Pretense of a Land Grant University	511	0.03	0.17	0	1	Association of Public and Land Grant Universities
Policy Variables	**Obs**	**Mean**	**Std Dev**	**Min**	**Max**	**Data Source**
Local Per Capita Sales Tax Revenues 1992	511	0.00	0.00	0	0.023533	US Census
Local Per Capita Spending on Health Care 1992	511	0.01	0.00	0.00435	0.015885	Economic Census 1992
Local Per Capita Spending on Highway Infrastructure 1992	511	0.01	0.00	0.000622	0.024515	Economic Census 1992
Local Per Capita Spending on Public Education 1992	511	0.05	0.01	0.02926	0.13888	Economic Census 1992
Local Per Capita Spending on Public Safety 1992	511	0.01	0.00	0.000804	0.021972	Economic Census 1992
Local Per Captia Property Tax Revenues 1992	511	0.03	0.01	0.00371	0.09937	USA Counties Program: US Census
Right to Work State	511	-	-	0	1	Yu and Rickman (forthcoming)
State Per Capita Spending on Highway Infrastructure 1992	511	0.01	0.00	0.007904	0.039311	Economic Census 1992

State Per Capita Spending on Public Safety 1992	511	0.01	0.00	0.007207	0.021361	Economic Census 1992
State Per Captia Corporate Income Tax Revenues 1992	511	0.00	0.00	0	0.0097879	Economic Census 1992
State Per Captia Income Tax Revenues 1992	511	0.02	0.01	0	0.039943	Economic Census 1992
State Per Captia Property Tax Revenues 1992	511	0.03	0.01	0.010091	0.060725	Economic Census 1992
State Per Captia Sales Tax Revenues 1992	511	0.02	0.01	0	0.051105	Economic Census 1992
Industrial Variables	**Obs**	**Mean**	**Std Dev**	**Min**	**Max**	**Data Source**
Employment in Ag-Service: Percent of Total Jobs	511	1.20	1.11	0	12.6	US Census
Employment in Farming: Percent of Total Jobs	511	6.26	3.64	0.4	20.8	US Census
Jobs in Construction: Percent of Total Private Non Farm Jobs	511	4.77	1.78	0	14.9	US Census
Jobs in Government: Percent of Total Employment	511	16.87	7.46	6.9	60.8	US Census
Jobs in Manufacturing: Percent of Total Private Non Farm Jobs	511	18.35	10.25	1.3	47.6	US Census
Jobs in Manufacturing: Percent of Total Private Non Farm Jobs	511	21.08	5.33	0	37.2	US Census
Jobs in Mining: Percent of Total Private Non Farm Jobs	511	1.54	3.35	0	25.2	US Census
The Unemployment Rate	511	7.07	2.39	1.9	15.7	US Census

Geographic Variables	Obs	Mean	Std Dev	Minimum	Maximum	Data Source
Distance to Next Metropolitan area	511	78.42	45.92	17.011	334.945	Partridge et al, 2010
Incremental Distance to the Next Metropolitan Area with a Population of 1.5 million or less	511	98.86	117.95	0	532.302	Partridge et al, 2010
Incremental Distance to the Next Metropolitan Area with a Population of 500,000 or less	511	34.42	55.11	0	362.772	Partridge et al, 2010
Incremental Distance to the Next Metropolitan Area with a Population of 250,000 or less	511	47.16	79.87	0	601.043	Partridge et al, 2010
Census Division Variables	**Obs**	**Mean**	**Std Dev**	**Minimum**	**Maximum**	**Data Source**
Census Divisions 2-9	511	-	-	0	1	US Census

Table 2. Reduced Form Regressions (robust t-statistics in parentheses)			
Variable	Population	Housing Rents	Wages
TempJan	0.57 (5.07)[a]	0.13 (0.83)	-0.47 (-3.64)[a]
TempJuly	-0.65 (-3.29)[a]	-1.21 (-4.47)[a]	0.43 (1.89)[c]
Humidity	-0.21 (-2.57)[b]	-0.15 (-1.35)	0.08 (0.83)
Water	0.07 (1.33)	0.33 (5.02)[a]	0.13 (2.21)[b]
Typography	0.17 (1.93)[c]	0.16 (1.34)	-0.02 (-0.23)
Dist to next Metro	-0.03 (-2.5)[b]	-0.08 (-5.62)[a]	-0.02 (-1.37)
IncDist250k	-0.02 (-2.67)[a]	-0.06 (-6.87)[a]	-0.02 (-2.42)[b]
IncDist500k	0.00 (-0.44)	-0.04 (-3.45)[a]	-0.02 (-1.76)[c]
IncDist1500k	0.00 (-0.26)	0.00 (-0.6)	-0.01 (-2.11)[b]
D2	5.04 (1.33)	23.75 (4.2)[a]	-0.55 (-0.13)
D3	9.93 (2.83)[a]	51.5 (9.56)[a]	4.75 (1.17)
D4	10.58 (2.76)[a]	42.94 (7.49)[a]	2.34 (0.53)
D5	18.06 (4.57)[a]	40.97 (7.01)[a]	1.03 (0.22)
D6	10.92 (2.65)[a]	38.67 (6.36)[a]	3.79 (0.79)
D7	7.96 (1.85)[c]	32.39 (5.14)[a]	5.52 (1.11)
D8	14.79 (2.78)[a]	62.28 (8.18)[a]	16.25 (2.64)[a]
D9	1.95 (0.34)	67.32 (8.47)[a]	13.44 (2.05)[b]
PopDens90	0.00 (-0.07)	NA	NA
MedGR90	NA	-0.09 (-7.22)[a]	NA
AvgWage90	NA	NA	-2.87 (-11.00)[a]
LandGrantU	0.54 (0.24)	-0.05 (-0.02)	-0.23 (-0.09)
%FarmJobs90	0.31 (1.83)[c]	0.3 (1.31)	0.17 (0.84)
%AgServJobs90	-1.27 (-2.87)[a]	-1.15 (-1.89)[c]	-1.03 (-2)[b]
%MinJobs90	-0.96 (-5.97)[a]	-1.17 (-5.22)[a]	-0.07 (-0.36)
%ConstJobs90	0.40 (1.54)	0.27 (0.77)	0.85 (2.84)[a]
%MfgJobs90	-0.2 (-2.5)[b]	-0.19 (-1.73)[c]	0.18 (1.94)[c]
%ServsJobs90	0.12 (1.14)	0.08 (0.57)	0.1 (0.82)
%GovJobs90	-0.13 (-1.37)	-0.30 (-2.24)[b]	-0.14 (-1.22)
%Bachelors90	0.88 (4.43)[a]	1.10 (3.81)[a]	0.48 (2.06)[b]
%High School90	-0.03 (-0.26)	-0.13 (-0.84)	-0.11 (-0.82)
%Unempl90	-0.29 (-1.02)	-0.89 (-2.26)[b]	-0.69 (-2.1)[b]
BirthRate90	0.72 (2.91)[a]	-0.87 (-2.56)[b]	-0.03 (-0.12)
%PopBlack90	0.01 (0.2)	0.15 (1.56)	0.17 (2.27)[b]
%PopHisp90	-0.14 (-2.39)[b]	-0.17 (-2.16)[b]	0.03 (0.51)
%PopAsian90	-0.41 (-0.37)	-3.59 (-2.39)[b]	1.30 (1.01)
%Age2549	0.25 (0.94)	0.50 (1.37)	0.58 (1.89)[c]
%Age5064	1.20 (2.38)[b]	1.81 (2.63)[a]	0.78 (1.34)

%Age65plus	-0.24 (-0.79)	-1.21 (-3.00)[a]	-0.29 (-0.84)
PCMrdHH90	0.73 (4.47)[a]	0.56 (2.37)[b]	0.23 (1.19)
Cty92property	-48.96 (-0.92)	-84.39 (-1.15)	-23.55 (-0.38)
Cty92sales	196.1 (1.47)	394.74 (2.16)[b]	-69.01 (-0.45)
Cty92highway	558.96 (3.71)[a]	455.18 (2.24)[b]	33.81 (0.19)
Cty92safety	-520.99 (-2.29)[b]	-157.89 (-0.51)	36.96 (0.14)
Cty92education	92.61 (2.05)[b]	135.95 (2.22)[b]	76.34 (1.46)
Cty92property	1.09 (0.01)	-26.56 (-0.2)	60.63 (0.54)
St92sales	-46.01 (-0.53)	-204.72 (-1.74)[c]	7.70 (0.08)
St92inctax	-218.53 (-3.26)[a]	-134.73 (-1.48)	-28.92 (-0.37)
St92corptax	-9.14 (-0.03)	-175.15 (-0.43)	169.92 (0.5)
St92hospitals	-604.83 (-1.97)[b]	-89.08 (-0.21)	47.75 (0.13)
St92highway	-93.3 (-0.65)	95.78 (0.49)	-289.3 (-1.74)[c]
St92safety	438.04 (1.35)	-1337.89 (-2.92)[a]	-109.44 (-0.29)
Right to Work	0.06 (0.04)	4.95 (2.29)[b]	2.54 (1.37)
R-Squared	0.558	0.718	0.392
F-statistic	11.6 (<.0001)	23.39 (<.0001)	5.81 (<.0001)

NA denotes not applicable
[a]denotes significant at or below the 0.01 level
[b]denotes significant at or below the 0.05 level
[c]denotes significant at or below the 0.10 level

TABLE 3. General Dominance Variance Analysis - Population Growth							
Combinations	**Amenity**	**Demographics**	**Education**	**Policy**	**Industry**	**Geography**	**Census**
K=0	0.120	0.100	0.012	0.165	0.139	0.035	0.159
K=1	0.097	0.104	0.040	0.157	0.146	0.030	0.138
K=2	0.074	0.099	0.045	0.096	0.138	0.027	0.116
K=3	0.056	0.091	0.045	0.068	0.122	0.023	0.097
K=4	0.044	0.082	0.041	0.050	0.104	0.018	0.083
K=5	0.035	0.071	0.034	0.040	0.085	0.013	0.073
K=6	0.027	0.057	0.025	0.035	0.064	0.008	0.067
Simple Avg.	0.065	0.086	0.035	0.087	0.114	0.022	0.105
Percent of Explained Variation	12.6%	16.8%	6.7%	17.0%	22.2%	4.3%	20.4%

Table 4. General Dominance Variance - Rent Growth							
Combinations	**Amenity**	**Demographics**	**Education**	**Policy**	**Industry**	**Geography**	**Census**
K=0	0.104	0.130	0.076	0.153	0.164	0.024	0.405
K=1	0.107	0.100	0.039	0.122	0.151	0.020	0.365
K=2	0.105	0.079	0.021	0.099	0.136	0.027	0.327
K=3	0.095	0.064	0.011	0.077	0.116	0.036	0.285
K=4	0.079	0.050	0.007	0.056	0.096	0.044	0.240
K=5	0.060	0.039	0.007	0.035	0.075	0.049	0.193
K=6	0.040	0.027	0.009	0.017	0.054	0.049	0.146
Simple Avg.	0.085	0.070	0.024	0.080	0.113	0.035	0.280
Percent of Explained Variation	12.3%	10.2%	3.5%	11.6%	16.5%	5.2%	40.8%

Table 5. General Dominance Variance Analysis - Wage Growth							
Combinations	**Amenity**	**Demographics**	**Education**	**Policy**	**Industry**	**Geography**	**Census**
K=0	0.019	-0.009	0.013	0.007	0.256	-0.002	0.011
K=1	0.025	-0.003	0.015	0.012	0.262	0.001	0.015
K=2	0.028	0.004	0.015	0.014	0.263	0.005	0.018
K=3	0.030	0.009	0.014	0.014	0.259	0.008	0.019
K=4	0.030	0.013	0.011	0.011	0.251	0.010	0.018
K=5	0.028	0.014	0.007	0.006	0.240	0.011	0.015
K=6	0.025	0.014	0.002	-0.002	0.229	0.012	0.011
Simple Avg.	0.026	0.006	0.011	0.009	0.251	0.006	0.015
Percent of Explained Variation	8.1%	1.9%	3.3%	2.7%	77.4%	1.9%	4.7%

TABLE 6. Significant Beta Coefficients- Population Regression					
	Amenity		Demographics		Education
TempJan	0.4821	PCMrdHH90	0.2664	%Bachelors90	0.2572
CCTypogC	0.1132	%Age5064	0.2048		
Humidity	-0.1958	BirthRate90	0.1508		
TempJuly	-0.2358	%PopHisp90	-0.1134		
	Policy		Industry		Geography
Cty92highway	0.1302	%FarmJobs90	-0.2112	DistMA	-0.1312
Cty92education	0.0527	%AgServJobs90	-0.0835	IncDist250k	-0.1435
Cty92safety	-0.1410	%MfgJobs90	-0.2010		
St92inctax	-0.1434	%MinJobs90	-0.2993		
St92hosp	-0.2112				
	Census				
D5	0.4638				
D8	0.3404				
D6	0.2927				
D7	0.2103				
D4	0.1943				
D3	0.1704				

Table 7. Significant Beta Coefficients - Rent Regression					
	Amenity		Demographics		Education
Water	0.1016	%Age5064	0.1614	%Bachelors90	0.0036
TempJuly	-0.3653	PCMrdHH90	0.0593		
		%PopAsian90	-0.0714		
		BirthRate90	-0.1406		
		%PopHisp90	-0.1770		
		%Age65plus	-0.2834		
	Policy		Industry		Geography
Cty92highway	0.1325	%MfgJobs90	-0.0661	Incmetgt500k	-0.0255
RTW	0.1318	%AgServJobs90	-0.0670	DistMA	-0.1267
Cty92education	0.0336	%Unempl90	-0.1004	IncDist250k	-0.1890
Cty92sales	0.0239	%GovJobs90	-0.1646		
St92sales	-0.0636	%MinJobs90	-0.2623		
St92pblsfty	-0.1115	MGR90	-0.3731		
	Census				
D3	1.2022				
D4	0.9807				
D5	0.8848				
D8	0.8839				
D9	0.8374				
D6	0.8363				
D7	0.7421				
D2	0.3799				

Table 8. Significant Beta Coefficients - Wage regression

	Amenity		Demographic		Education
TempJuly	0.1783	%PopBlack90	0.1187	%Bachelors90	0.1945
Water	0.0991	%Age2549	0.0802		
TempJan	-0.3987				
	Policy		Industry		Geography
St92highway	-0.1174	%MfgJobs90	0.2011	IncDist500k	-0.0740
		%ConstJobs90	0.1601	IncDist1500k	-0.0932
		%AgServJobs90	-0.1060	IncDist250k	-0.0963
		%Unempl90	-0.1519		
		AvgWage90	-0.5793		
	Census				
D8	0.2175				
D9	0.1012				

Table 9. Residual Analysis

	Residual Population Growth	p-value
Residual Amenity Effect	0.067	0.132
Residual Productivity Effect	0.175	<0.001
Residual Housing Effect	-0.202	<0.001