Recent Spatial Growth Dynamics in Wages and Housing Costs: Proximity to Urban Production Externalities and Consumer Amenities

by

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Abstract: Despite advances in communications and transportation technology, remoteness within the United States has been increasingly associated with relatively lower economic growth. Using a hedonic pricing approach, this paper assesses the relative importance of proximity to urban consumer amenities and production spillovers in explaining growth differentials in wages and housing costs across the U.S. urban hierarchy. In general, we find that productivity disadvantages *increased* with remoteness from urban agglomeration over time. At the same time, we find remoteness from larger metropolitan areas as *increasingly* attractive to households. In decomposing these influences on wage growth differentials, we find that the dominant force for lower wage growth in remote nonmetropolitan and small metropolitan-area counties is increasing relative productivity disadvantages. Yet, for medium-to-large metropolitan areas, increased attractiveness to households of remoteness from even larger metropolitan areas generally contributed the most to relatively weaker wage growth.

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1. INTRODUCTION

Recent advances in information and communications technology, deconcentration of manufacturing, globalization, and improved transportation might have been expected to reduce the advantages associated with density of economic activity and the economic penalty for remoteness. Yet, during the 1990s, large U.S. metropolitan areas continued to prosper while remote areas continued to stagnate. Metropolitan area (MA) population growth significantly exceeded the rest of the nation during this period, in which growth was strongest in MAs with population between 1–2.5 million and weakest in those with less than 100,000 people (U.S. Census Bureau, 2005). Partridge et al. (2008a; 2008b) similarly found people and jobs concentrating nearer larger urban centers during the 1990s. Using an urban hierarchy approach, they found lower growth in areas positioned at greater distances from larger (higher-tier) urban areas. This continued a U.S. core-periphery population growth pattern established in earlier decades (Barkley et al., 1996; Partridge and Rickman, 2008b). The continued importance of core-periphery interactions for regional growth has been similarly reported for other developed countries (e.g., Polèse and Shearmur, 2004; Rietveld and Vickerman, 2004).

Numerous explanations have been offered for the continued growing economic prominence and broader geographic influence of large MAs. Large cities offer a number of consumer amenities not found elsewhere (Glaeser et al., 2001) such as exotic restaurants, nationally-renowned museums, and specialized healthcare facilities. While there also are potential disamenities such as environmental pollution and higher crime, Glaeser and Shapiro (2003) argue that quality of life on balance likely increased in larger MAs over this period. In addition, as for natural amenities, the demand for urban amenities may have grown with the rise in real U.S. income and wealth (Graves and Mueser, 1993). Yet, these urban amenity effects could be offset by an increased desire to be closer to nature or to live in less congested environments.

Productivity advantages for firms locating in or near large MAs also may have increased. For example, face-to-face contacts may complement technology instead of serving as a substitute, in which there is an urban bias in the provision of information technology (Sinai and

Waldfogel, 2004; Forman et al., 2005). Large cities would be further advantaged if modern commerce requires a higher frequency of interaction and face-to-face contact (McCann, 2007). Access to higher-order legal, accounting and management services more likely require face-to-face interaction. Time-sensitive and low-cost access to thick labor markets and material inputs may increase in importance as idea generation and knowledge fetches ever higher premiums (Glaeser and Ponzetto, 2007). Thus, even as "spatial transmission" costs may have decreased, "spatial transactions" costs may have increased (McCann, 2008).

Spatial patterns in employment and population growth do not reveal the relative contributions of urban consumer amenities versus firm productivity advantages because employment and population both are outcomes of the interaction of labor demand and supply. A standard method for separating household and firm location influences on regional economic activity is hedonic pricing (Beeson and Eberts, 1989; Gabriel and Rosenthal, 2004; Chen and Rosenthal, 2008). Increased consumer preferences for an area are revealed by the lower wages workers are willing to accept. Increased productivity advantages are revealed by the increased input costs firms are willing to pay.

This paper ascertains whether the strong economic performance of larger MAs and weaker performance of counties in lower-tiers of the urban hierarchy during the 1990s was derived more from firm location or household location considerations. Using Census and Geographic Information System (GIS) data, we examine patterns of factor price changes for all counties in the continental U.S. A novel contribution is the consideration of small MAs and nonmetropolitan areas in an explicit mapped-out urban system, in contrast to related studies that examined large cities (Gabriel and Rosenthal, 2004) or states and broad regions (Chen and Rosenthal, 2008).

Using an urban hierarchy framework, Partridge et al. (2009) found productivity disadvantages as primarily underlying lower household earnings and housing prices in remote areas, but this relates to the spatial equilibrium distribution of *levels* of economic activity at a point in time, not to spatial differentials in *growth*. Rather, this study assesses whether unanticipated shocks alter the core-periphery spatial equilibrium, leading to differential *changes* in factor prices. The factor price changes then are decomposed to reveal whether they are due to changes in firm productivity or in household urban amenity preferences. We also examine whether migration across age cohorts and the most educated are consistent with our productivity/amenity findings.

The next section lays out the hedonic pricing framework as it applies in our setting and shows how household amenity effects can be identified separately from firm productivity effects. The section also presents our conceptualization of the urban hierarchy. Section 3 contains the empirical model and describes its implementation. The results are presented and discussed in Section 4. Among our findings, the poorer economic performance of lower-tiered areas in the 1990s was primarily due to increasing productivity disadvantages of remoteness. Conversely, remoteness from large metropolitan areas appears to be increasingly household amenity attractive. We confirm these patterns in analyses of changing age and education cohort population shares, in which we find younger and more educated households locating closer to large MAs, while older households move to more remote areas. The final section briefly summarizes the results and concludes the paper.

2. THEORETICAL FRAMEWORK

2.1 Hedonic Model

Our approach follows the quality-of-life hedonic pricing approach (Roback, 1982; Blomquist et al., 1988) as extended to also consider the quality of business environment by Beeson and Eberts (1989), Gabriel and Rosenthal (2004) and Chen and Rosenthal (2008). Ottaviano and Pinelli (2006) similarly use this approach in examining whether New Economic Geography agglomeration economies in Finland primarily derived from household or firm location considerations. To be sure, the framework is sufficiently general to capture a wide variety of agglomeration and quality-of-life factors (Tabuchi and Thisse, 2006, p. 1299).

We begin by writing the representative household's indirect utility function as

(1) $V=V(w_i, r_i \mid \mathbf{A}_i^h, \mathbf{D}_i^h)$,

where w_i is the wage rate, r_i is the rental rate of land, A_i^h is a vector of household (h) amenities in the area which could include both natural (e.g., weather) and man-made amenities (e.g., those related to urban agglomeration), and $\mathbf{D}_i^h$ represents distance-based household costs to access consumer goods and services in the higher tiers of the urban hierarchy, which is influenced by the distances to higher-tiered areas, costs to traverse the distances, the array of available consumer goods and services, and household preferences.

The firm's indirect profit function likewise can be written as

(2) $\Pi = \Pi(w_i, r_i \mid \mathbf{A}_i^f, \mathbf{D}_i^f)$,

where $\mathbf{A}_i^f$ is a vector of firm (f) amenities in the area (e.g., topography or proximity to a harbor), and $\mathbf{D}_i^f$ is a vector of distance-based costs to access firm amenities in higher tiers of the urban hierarchy, which is influenced by the distances to higher-tiered areas, costs to traverse the distances, and the extent of firm agglomeration economies in these areas.

Following the literature, a traded good is produced under constant returns to scale with a nationally-normalized price equal to one. Residential rent per unit of land is assumed equal to firm rent. Rents and wages both are assumed to be quality adjusted. Perfect mobility of firms and households equalize indirect utility and profits across areas, in which differences in site characteristics are associated with equilibrium wage and rent differentials. As demonstrated in earlier studies and shown in Figure 1, this framework implies upward sloping iso-utility curves and downward sloping iso-profit curves in wage (w) and rent (r) space, in which a given vector of within-area amenities and location in the urban hierarchy imply a unique equilibrium combination of w and r.

Holding within-area amenities ($\mathbf{A}_i$) constant for both firms (f) and households (h), Figure 1 shows the effects of greater remoteness from larger cities, assuming it reduces access to urban consumer amenities and firm productivity-enhancing spillovers. Lower access to positive firm spillovers shifts the iso-profit curve leftward, reducing wages and rents. Increased remoteness from urban consumer amenities likewise shifts the iso-utility curve leftward (better access is valued more highly than is avoidance of congestion that may be associated with large and dense agglomerations), reducing rents and increasing nominal wages (thus increasing real wages). Rent unambiguously decreases with greater remoteness. Here, greater remoteness also reduces the wage rate because the leftward shift of the iso-profit curve is greater than the iso-utility curve.

The spatial differences in wages and rents due to remoteness can change over time if **D** changes for households and/or firms. For example, despite advances in communication and transportation technologies, if face-to-face interactions are becoming more important to commerce, the costs of remoteness to firms (**D**) may be increasing. An increased preference for urban amenities by households also would increase **D** on the household side. So, Figure 1 can represent changes in wages and rents that occur as the economy transitions from one spatial equilibrium to the next (Dumais et al., 2002; Shapiro, 2006; Glaeser and Tobio, 2008) in response to changing costs of remoteness. Where the effect on firms dominates, as in Figure 1, such changes lead to a reduction in both rents and wages for more remote areas.

The changes in wages and rents in response to a change in **D** can be decomposed into the parts attributable to household relocation versus firm relocation. The effects depend on the size of the shifts and slopes of the curves. In Figure 1, the productivity effects are given by r_1-r_3 and w_1-w_3, while the household amenity effects are given by r_3-r_2 and w_3-w_2. They can be obtained analytically as follows.

Assuming linearity around the factor space of inquiry (Beeson and Eberts, 1989), the slope of each curve is defined by the shift in the other curve:

(3) $(dw/d\mathbf{D})^{\Pi}/(dr/d\mathbf{D})^{\Pi} = T^h$

(4) $(dw/d\mathbf{D})^{V}/(dr/d\mathbf{D})^{V} = -T^f/L^f$,

where T denotes land, and L denotes labor. To decompose the remoteness effect on wages, we solve Equations (3) and (4) for the productivity and amenity wage components and sum them to obtain the total wage change:

(5) $dw/d\mathbf{D} = T^h(dr/d\mathbf{D})^{\Pi} -(T^f/L^f)(dr/d\mathbf{D})^{V}$.

Using the expression $(dr/d\mathbf{D})$ as the sum of the amenity and productivity components and solving for $(dr/d\mathbf{D})^{V}$ in Equation (4), Equation (5) can be solved for the following amenity component:

(6) $(dw/d\mathbf{D})^V = [(T^f/L^f)/(T^f/L^f+T^h)]*(dw/d\mathbf{D}-T^h(dr/d\mathbf{D}))$.

The productivity component can be obtained from subtracting the result for Equation (6) from $(dw/d\mathbf{D})$. As the model assumes that consumer prices only vary geographically because of land prices, the second term in Equation (6) reflects the change in real wages.

As indicated in the empirical section, because we measure unit housing prices and not land prices, we re-express Equation (6) in terms of housing prices. Following the hedonic quality-of-life literature (e.g., Beeson and Eberts, 1989), and empirically supported by Davis and Palumbo (2008), we assume that differentials in housing prices relate to land price differentials and not to differences in replacement costs of structures: $P^h=rT^h/h$, where P^h is the unit price of housing and h denotes quantity of housing units. Substituting the log differential of the expression for the unit price of housing into the log differential of Equation (6), and using the full employment equilibrium conditions for labor and land, yields the following

(7) $(d\log(w)/d\mathbf{D})^V=[(rT^f/wL^f)/(rT/wL)]*(d\log(w)/d\mathbf{D}-\theta^h d\log(p^h)/d\mathbf{D})$,

where θ^h is the household budget share spent on housing and the second term continues to reflect the real wage rate. Price adjustment is in terms of the housing price change.

2.2 Costs Associated with Proximity in the Urban Hierarchy

Proximity in the urban hierarchy affects household costs of accessing urban consumption amenities and firm costs of accessing urban production amenities. Cities at each tier are assumed to offer consumer and producer services that are available in lower-tier cities, *plus* additional higher-ordered amenities. The top tier (n) has the full range of producer and consumer goods and services; the first or lowest tier has the fewest. For any tier below the top, there are marginal costs of accessing incrementally higher-ordered producer services or urban amenities.

Following Partridge et al. (2008a; 2008b) the distance-based costs for area *i* in tier *j* of *n* tiers of cities in the urban hierarchy are as follows. Each successive higher-tier of urban areas (j+1, j+2…*n*) has successively higher orders of consumer and producer amenities. The marginal distances are defined by the differences in distances between nearest places in tiers j and j+1; j+1 and j+2; j+2 and j+3; etc. For each *i*, beyond the own-tier place *j* in the hierarchy, let the marginal distance to the nearest place in the higher tier equal d^k and the corresponding marginal cost per unit of distance (combination of lower productivity and access to urban amenities) equal φ^k. The φ terms include the *net* contributions of lower productivity, access to urban household amenities, and distance from urban congestion/disamenity effects.

The potentially varying values for φ^k across urban tiers allow the total distance costs to have different segments, allowing for nonlinearity of effects across space. The total distance-based costs and the corresponding *change* in total distance costs between periods t and t+1 (for both households and firms) can be expressed as:

(8) $\mathbf{D}_{ij} = \sum_k d^k\varphi^k$, $d\mathbf{D}_{ij} = \sum_k d^k\Delta\varphi^k$,

where the summation is over $k=j+1$ to the n^{th} tier.

Corresponding to Figure 1, although the marginal distances (d^k) between places in the urban hierarchy should be fairly stable, especially relative to the top-tiered areas (Black and Henderson, 1999; Eeckhout, 2004), the marginal costs per unit of distance (φ^k) can vary with changing technology, characteristics of large cities or preferences, thus affecting the net cost of economic remoteness. Developments favoring larger cities–higher-tiered places in the hierarchy–cause $d\mathbf{D}$ to increase in absolute value, corresponding to larger leftward shifts of the iso-utility and iso-profit curves. Thus, places lower in the urban hierarchy should experience falling relative rents over time because of the negative effects on both firms and households. However, to the extent households increasingly prefer close proximity to urban amenities, there are offsetting positive (negative compensating differential) effects on wages in remote areas.

Changes in the marginal cost of distance may be tier specific as well. Relative to rural areas, industry compositions may produce stronger production linkages between small and large MAs. In this case, *changes* in access costs associated with greater distance from a large MA may be larger for small MAs than for rural areas. Increased urban congestion costs faced by households also could dominate the value of proximity to higher-tier urban amenities and shift the iso-utility curve rightward. These dynamics would enhance the adverse productivity effects of remoteness of small MAs from large MAs on wages, but moderate the corresponding rent-reducing effect.

3. ECONOMETRIC IMPLEMENTATION

Our sample consists of over 3,000 counties in the lower 48 U.S. states. We separate these counties into three sub-samples due to the expected heterogeneity of economic linkages. As discussed above, for example, proximity to larger urban areas likely has differential impacts on small MAs versus nonmetropolitan areas because of their differing industry compositions. Thus, the first sub-sample contains nonmetropolitan counties (i.e., non MA counties), including lesser-populated rural areas, towns, and small cities with less than 50,000 people. The remaining two sub-samples are counties that are part of MAs with less than 250,000 people ("small" MAs) and those that are part of more populated MAs ("medium" and "large" MAs).[1, 2] The 250,000 population threshold creates two metropolitan samples of approximately the same size.

We follow the hedonic literature in assuming the system is approximately in spatial equilibrium at the beginning and end of the sample period. Consistent with d**D** in Equation 8, any equilibrium change in factor prices and factor movements over the decade is assumed to reflect adjustments to shocks or changes in conditions that occur over the period (Dumais et al., 2002; Shapiro, 2006; Glaeser and Tobio, 2008). Our empirical analysis is conducted in two steps. First, we consider differences in the natural logs for (1) average wage per job in 2000 and 1990 (ΔWAGE) and for (2) median housing costs in 2000 and 1990 (ΔHCOST). The average wage is derived from the Bureau of Economic Analysis wage and employment data, while median housing costs are derived from U.S. Census 1990 and 2000 SF3 files.[3] Housing costs should be a good proxy for land rents because quality-adjusted housing prices mostly result from differences in land values (Davis and Palumbo, 2008).[4]

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[1]We use the U.S. Bureau of Economic Analysis definitions of counties. Forty three mostly small rural counties are omitted due to the lack of economic data.

[2]Aggregate county-level data are employed because individual census level housing and earnings data do not contain geo-identifiers for the two-thirds of counties that are nonmetropolitan, which would preclude analysis of them (i.e., we would be forced to only consider larger metropolitan areas). Studies like ours that utilize aggregate-level data to capture finer spatial detail include Hanson (2005), Head and Mayer (2006) and Partridge et al. (2009).

[3]Consistent with other hedonic studies (Blomquist et al., 1989; Chen and Rosenthal, 2008), we use wage rates of the worker, which implicitly assumes the typical worker is the primary purchaser of a household's housing or is single.

[4]The variable ΔHCOST is the weighted average median gross rent ($ per month) of owner and renter-occupied housing units (Gabriel et al., 2003). Following other hedonic and housing market-related studies (Blomquist et al., 1988; Beeson and Eberts, 1989; Gabriel and Rosenthal, 2004; Glaeser et al., 2006) owner-occupied median-housing prices are converted into imputed annual rent using Peiser and Smith's (1985) discount rate of 7.85%. The monthly

Primarily as confirmatory analysis of the hedonic results, a second set of dependent variables is used to examine migration adjustments during the 1990s. We construct changes in cohort size over the 1990s by taking the difference in shares of population age cohorts between 1990 and 2000 (ΔAGESH). The specific population cohorts are 25-29, 30-34, 35-39, 40-49, 50-59, 60-69, 70-79, and 80+ year olds, also from the U.S. Census SF3 files. The differences in changes in cohort size should be largely related to differences in internal migration.[5]

Younger cohorts are more likely to be affected by productivity shocks because by human capital theory, they are more likely to be economic migrants, while older cohorts are more likely to be amenity migrants. So, if productivity underlies the strong performance of cities in the 1990s, younger households would most likely be moving to cities. The migration patterns among age cohorts should then be consistent with our hedonic findings regarding the relative importance of productivity and amenities. We estimate an additional complementary regression that considers the 1990-2000 change in the population over 25 years old that are four-year college graduates (ΔCOLGRAD). College graduates should be more likely to migrate to places that experience positive productivity or urban consumer amenity shocks.

Thus, we first specify two reduced-form hedonic equations for the 1990-2000 log change in wage rates (*ΔWAGE*) and the 1990-2000 log change in housing costs (*ΔHCOST*). We next specify two reduced-form equations for the 1990-2000 change in age-cohort shares (*ΔAGESH*) and the 1990-2000 change in shares of the population that are four-year college graduates (*ΔCOLGRAD*). Because the geographic and economic variables that alter factor prices should also underlie migration patterns and cohort shares, the specifications for the four dependent variables are similar with exceptions such as measures of housing quality only appearing in the *ΔHCOST* equation and demographic variables only appearing in the *ΔWAGE* equation. Except

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average of this figure along with the median monthly rent for the renter-occupied units, weighted by the shares of owner- and renter-occupied houses, is our median housing cost variable.

[5] For example, based on intercensal population estimates for U.S. states over the period 1990-1999 (U.S. Census Bureau, 2009), the coefficient of variation for the rate of state population growth attributable to births minus deaths is 0.013 while that for the sum of international and internal migration is 0.151.

for the distance measures, most of the explanatory variables are from U.S. Census Bureau SF3 files (details are provided in Appendix Table 1).

In each of the three sub-samples, for county i, located in state s, the empirical equations are:

(9) $\Delta WAGE_{ist} = \alpha^{W} + \varphi^{W} GEOG_{ist-1} + \gamma^{W}\text{AMENITY}_{is} + \delta^{W}\mathbf{X}_{ist} + \lambda^{W} WAGE_{ist-2} + \sigma^{W}_{s} + \varepsilon^{W}_{ist},$

(10) $\Delta HCOST_{ist} = \alpha^{H} + \varphi^{H} GEOG_{ist-1} + \gamma^{H}\text{AMENITY}_{is} + \delta^{H}\mathbf{X}_{ist} + \lambda^{H} HCOST_{ist-2} + \sigma^{H}_{s} + \varepsilon^{H}_{ist},$

(11) $\Delta AGESH_{ist} = \alpha^{AS} + \varphi^{AS} GEOG_{ist-1} + \gamma^{AS}\text{AMENITY}_{is} + \delta^{AS}\mathbf{X}_{ist} + \lambda^{W} RESWAGE_{ist-1} + \lambda^{H} RESHCOST_{ist-1} + \sigma^{AS}_{s} + \varepsilon^{AS}_{ist},$

(12) $\Delta COLGRAD_{ist} = \alpha^{CG} + \varphi^{CG} GEOG_{ist-1} + \gamma^{CG}\text{AMENITY}_{is} + \delta^{CG}\mathbf{X}_{ist} + \lambda^{W} RESWAGE_{ist-1} + \lambda^{H} RESHCOST_{ist-1} + \sigma^{CG}_{s} + \varepsilon^{CG}_{ist}.$

GEOG contains distance measures to various tiers in the urban hierarchy (d^{k}), measures of market potential, and other variables capturing geographic characteristics of the county; **AMENITY** has measures of natural amenities in the area; **X** is a vector of control variables; and state fixed effects σ_s account for common state-specific factors.

Also included are the 1980 average wage ($WAGE_{ist-2}$) in the $\Delta WAGE$ equation and 1980 housing costs ($HCOST_{ist-2}$) in the $\Delta HCOST$ equation. These variables control for any pre-existing disequilibrium adjustments that spill over into the 1990s and any capitalization of *expected* influences of technological shocks into wages and housing costs. The distance variable coefficients should then more cleanly reflect how unanticipated shocks during the 1990s influenced changes in wages and housing costs. *RESWAGE* and *RESHCOST* are the residuals from two regression equations that use 1990 natural logs of wages and housing costs as dependent variables. As described below, the residuals capture disequilibrium effects, or the degree to which a potential migrant is over- or under-compensated in labor and housing markets at the beginning of the period (Clark et al., 2003). The regression coefficients are α, φ, γ, δ, and λ; and ε is the residual. The specific variable sources and definitions are described in Appendix Table 1.

The urban hierarchy distance measures (d^{k}) in Equation (8) represent the primary variables of interest in the **GEOG** vector. First, for a rural county, we include the distance from the population-weighted county center to the population-weighted center of the nearest urban center (either a metropolitan area (MA) or a micropolitan area (MICRO)).[6] For urban counties, part of an MA or a MICRO, this first distance is measured from the population-weighted center of the county to the population-weighted center of its *own urban* area. *Within* an urban area, the effect of this distance reflects *intrametropolitan* effects such as congestion, local land use, and zoning. Yet, given our interest in *inter*-urban area effects, we do not focus on this *within*-urban area variable when discussing the urban hierarchy distance results.

Second, beyond the nearest/own urban center of any size, as indicated by our theory we include the *incremental* distances to more populous higher-tiered urban centers.[7] The first incremental distance is that from the county to reach an MA.[8] We also include the incremental distances to reach an urban center with population of at least 250 thousand, at least 500 thousand and at least 1.5 million.[9] The largest urban tier generally reflects national and primary regional centers. For any county, the *sum* of the (incremental) distances equals the distance to an MA of at least 1.5 million people. An illustration of the distance measures can be found in Partridge et al. (2008b). Because marginal effects can differ across tiers, this approach allows for nonlinearity across the total distance to the top-tier area. The coefficients corresponding to the distance variables (d^k) in the vectors, φ^W and φ^H, represent $\Delta\varphi^k$ in Equation (8), and capture the combined changing urban productivity and consumer amenity effects of proximity in the urban hierarchy. Although these distances may not perfectly reflect road network distances or travel times, the latter can be endogenous, while the existence of any measurement error would bias the distance

[6]MICRO areas are defined as counties containing a city of between 10,000-50,000 people plus those counties with tight commuting links. A MA is similarly defined for counties that encompass a city of at least 50,000. We use the 2003 urban area definition because it allows us to use MICROs (first defined in 2003) and to include counties in the metro sample if they had emerging commuting linkages. See the Census Bureau MA and MICRO definitions at www.census.gov/population/www/estimates/metrodef.html.

[7]Use of actual distances in place of incremental distances also would introduce unnecessary multicollinearity (Partridge et al., 2008a).

[8]For example, for a county already located in a MA, the incremental distance to reach an MA (of any size) would be zero because it already is a MA county. Population-weighted county centroids are from the U.S. Census Bureau. The MA population categories use 1990 population.

[9]For a county that is already nearest to a MA that is either larger than or equal to its own size category, the incremental value is 0. For example, if the county's nearest urban center of any size is already over 500,000 people and 55kms away, then the nearest urban center is 55kms away and the three incremental distance values for nearest MA of any size, nearest MA> 250,000, nearest MA with at least 500K population are equal to zero.

coefficients towards zero, working against finding distance effects on factor price growth.[10]

The vector **GEOG** also contains measures of nominal market potential, represented by aggregate household income in surrounding 100-200, 200-300, 300-400, and 400-500km concentric rings measured from the county's population-weighted center, which allows for a flexible functional form (Partridge et al., 2009).[11] We use lagged (1989) measures of market potential to mitigate any direct endogeneity.[12] Aggregate income within 100km of the county of interest is not included because it would introduce endogeneity by definition—i.e., the largest element of household income is wage earnings, one of our dependent variables. Many past studies similarly remove the own region or the own country in calculating market potential to address this concern (Redding and Venables, 2004; Head and Mayer, 2006; Knaap, 2006). In our study, the own county population and population of the own or nearest urban center controls for local market potential, in which they also may capture the balance of within-area man-made amenities versus congestion costs.

Finally, **GEOG** also includes the county's population and area in square miles. If the county is part of a MA or MICRO, we include the total MA/MICRO population. We use population of the *nearest* urban area in the nonmetro samples. Greater county size suggests lower employment density and more space to construct housing. It also implies greater distance *within* the county to reach higher-order services and customers that may affect *within*-region agglomeration spillovers.

The **X** vector somewhat differs across the equations. In the wage and housing cost equations, we control for beginning-of-period industry composition effects so that our distance variables do not pick up industrial restructuring effects such as those related to the decline of agriculture. For

[10]Combes and Lafourcade (2005) found that the correlation between geographic distances and French transport costs is 0.97, suggesting that with the developed road network in the U.S., measurement error should be slight.
[11]A county's household income was included in a ring if its population-weighted centroid fell in that ring. A 500km limit follows Hanson's (2005, p. 20) conclusion that the effects of shocks to market potential barely extend beyond 400km. Another way would be to inversely weight neighboring county income by the distance from the county, but our approach is more flexible because we do not have to find an optimal weighting scheme.
[12]In addition to possible correlation in measurement error with using current market potential measures, there is a possibility that there is an omitted factor or shock that contemporaneously increases wages and housing prices in both the county and the broad region, which creates endogeneity bias. Lagging the market potential measure 10 years reduces the likelihood of such direct endogeneity.

the wage and cohort change models, **X** includes 5 measures of ethnicity, 4 measures of educational attainment, and the shares of the population that are female, married, and possess a work disability, all measured in 1990 to avoid endogeneity; whereas, the wage equation also includes six population age-share measures from 1990. The housing cost equation contains measures of the age of the average housing unit, size of the housing stock, the share of mobile units, the share with complete plumbing, and the share with complete kitchen facilities, all measured in 1990. See Appendix Table 1 for more details.

We also account for possible causes of labor supply shifts and other site attributes that may influence firm location. Natural amenities (**AMENITY)** are measured by four climate variables, a 1 to 24 scale variable related to topography, percent water area, and three dummy variables for location within 50kms of the Pacific/Atlantic Ocean, and Great Lakes. State fixed effects account for factors such as settlement period, tax, expenditure, and regulatory policies, or natural resources. With state fixed effects included, the other coefficients are interpreted as average responses for *within*-state changes in the explanatory variables. The county residual is assumed to be spatially correlated with neighboring counties within a specified bandwidth; the correlations are assumed to decrease with distance between the two counties. A generalized method of moments (GMM) procedure is used to estimate t-statistics that are robust to general forms of cross-sectional spillovers or spatial autocorrelation (Conley, 1999).[13]

4. EMPIRICAL RESULTS

Appendix Table 1 displays the descriptive statistics for the full sample; those for selected sub-samples appear in Appendix Table 2. Table 1A contains the base *ΔWAGE* regression results for our sub-samples: nonmetropolitan area counties, small MAs with less than 250K people, and large MAs with more than 250K people. Table 1B contains the corresponding results for *ΔHCOST*.

4.1 Base Hedonic Regression Results

The first set of hedonic results in columns 1-3 of Tables 1A and 1B are for the model that

[13]The bandwidth is 200kms, after which we follow convention and assume no correlation in county residuals. The procedure is a generalization of the Huber-White heteroscedastic-consistent estimator, in which they are equivalent if all distances equal zero (Rappaport and Sachs, 2003).

does not include the respective 1980 levels of wages and housing costs. Columns 4-6 show the results obtained when the 1980 initial wage and housing cost levels are added to account for potential pre-existing disequilibrium effects on factor price growth and the capitalization of *anticipated* changes in the distance effects on factor prices. The results indicate a strong inverse relationship with 1980 levels, though smaller for housing costs than wages. The results for the other variables are robust to including the initial levels of wages and housing costs, supporting our equilibrium framework, and also suggesting that households and firms in 1980 did not greatly anticipate the 1990 urban hierarchy shocks. From here on, the results from the models that include the 1980 wage and housing costs (columns 4-6) are treated as the base results.

Turning to the incremental distance results, the coefficients are generally negative and statistically significant in the wage growth equation, except the incremental distance to reach a MA of at least 1.5 million in the two MA samples. At the bottom of the table are joint F-statistics on all the distance variables and for all of the incremental distance variables as a subgroup (omitting the distance to the center of the county's own metropolitan area). Except in the large MA sample, the incremental distance variables are jointly statistically significant. Although there are some differences, the same general patterns also apply to the housing cost regression. The market potential variables are generally insignificant for wage growth, either individually or as a group, though they are significant for housing price growth. Where they are significant, however, the market potential variables generally are of the wrong sign. In re-estimating the model by omitting the market potential variables, the distance results are approximately the same (not shown), indicating that the urban hierarchy distance effects are not an artifact of including market potential variables in the model.

For added perspective, near the bottom of the table we show the cumulative distance effects, which are calculated by summing the results of multiplying the significant distance regression coefficients by the respective variable mean values from Appendix Table 2 and expressed in percentage terms. Measured at the mean distances, a typical nonmetropolitan, small MA, and large MA, county experienced respectively 3.14%, 1.80%, and 0.54% less wage growth during the

1990s due to their remoteness, while they also respectively had 9.20%, 4.23%, and 0% lower housing costs increase over the course of the decade. The strong adverse effects on both wage and housing cost growth over the decade indicate the costs of distance were rising and that these effects were largely unanticipated as of 1980.

The insignificance or wrong sign of the coefficients associated with the market potential variables suggests that although market potential and related New Economic Geography explanations may be helpful in explaining factor price *levels*—i.e., market potential has been reported to be *positively* related to factor prices (Hanson, 2005; Head and Mayer, 2004, 2006) — they do not explain recent factor price growth dynamics in the United States. The stronger findings for the distance variables suggest that the developments of the 1990s, such as advances in communication and transportation technology, worked more through the channels of the urban hierarchy than generically through market size.

Another result of interest is that all else equal, there was generally no statistical association between 1990-2000 wage growth rates and favorable demand shocks at the county level, as measured by their 1990-2000 employment growth attributable to their industry composition (not shown). This result indicates that significant distance effects are related to factors such as strengthening agglomeration economies, not concurrent demand shocks. It also suggests that any favorable demand shocks were offset by positive in-migration that returned wages to their equilibrium levels. This would apply especially if productivity is unaffected by demand shocks such that firms could not offer higher nominal wages without degrading their competitiveness.

4.2 Decomposition of Distance Effects on Wage Growth

The base regression results discussed above provide the estimates of the impact of d**D** in Equation (8) on both wage growth and housing price growth. Yet, the estimated decline in relative wage growth in remote areas could be attributed to either growing negative productivity disadvantages or to (net) positive household effects. The latter would imply a net positive re-evaluation of remoteness from urban agglomerations, due to congestion or other disamenities associated with large dense agglomerations, which are sufficient to outweigh the costs of reduced access to urban consumer amenities. The general negative effects of remoteness on housing price growth suggest that even if remoteness became more *household* attractive on balance, increased negative *firm* productivity effects must have dominated. To determine whether remoteness became increasingly household attractive, and correspondingly, how much increased productivity disadvantages contributed to weaker relative wage growth, we substitute estimates of d**D** from Tables 1A and 1B into a numerically-calibrated Equation (7) (i.e., the derived expression for the household amenity component of distance-related wage growth).

4.2.1 Base Decomposition

To calibrate Equation (7), we re-express the bracketed term as $(rT^f/rT)/(wL^f/wL)$. Based on average values for the nation reported in the literature (Barker and Sa-Aadu, 2004), the numerator in this term is estimated to equal 0.64 and the denominator is estimated to be 0.9978, making the ratio equal to 0.6414.[14] The second term requires the share of the household budget spent on housing, which we estimate from Census 2000 data as 0.2298.[15] We examine the sensitivity of the decomposition to alternative parameterizations in the subsequent subsection.

Panels A through C in Table 2 show the results of the decomposition of wage growth differentials for each sub-sample into household and firm-productivity effects by distance variable. The first column in each panel displays the sub-sample mean for each distance variable. These are multiplied by the corresponding urban hierarchy distance regression coefficients from the wage and housing cost regressions to obtain dlog(w)/d**D** and dlog(p^h)/d**D** in Equation (7) for each distance variable. The nominal wage component is shown in the second column, while the

[14]Barker and Sa-Aadu (2004) estimate that rental income of persons as a share of national income was 1.8% in 2000, which includes imputed rent for owner-occupied housing. They estimate an upper bound of the sum of net real estate rental income of partnerships and net rental income of corporations as 1% of national income. They also estimate imputed rent from owner-occupied commercial real estate as 2.2% of national income in 2000, bringing the total of rental income not associated with persons equal to 3.2%. Hence, (3.2/(3.2+1.8))=0.64. We measure wN^f as labor compensation in GSP in 1997 and wN as compensation of employees received from national income in 1997, producing a ratio of 0.9978. We use 1997 because subsequently GSP is reported in NAICS code and does not report employee compensation; yet, using the same procedure the ratio was 0.994 in 1990, indicating stability across time.

[15]Specifically, it is calculated as: [owner-occupied share of housing units*median owner occupied expenses share of household budget for those with a mortgage] + [renter-occupied share of housing units* median gross rental expenses share of the household budget] based on Census 2000 values in the SF3 file. Davis and Orthalo-Magne (2007) provide evidence that the housing share of consumption does not vary much geographically.

third column shows the real wage growth effect (second term in Equation (7)). The fourth column shows the nominal wage growth differential attributable to household effects, $(d\log(w)/dD)^V$, while column 5 displays the residual wage change attributable to productivity effects (column 2 minus column 4). Columns (6) and (7) express the results in columns (4) and (5) as shares of the total nominal wage growth differential. The last row for each panel contains the cumulative (or average) effect over all distance variables, excluding within urban area distance calculations for the MA samples.

As evidenced by the negative change in real wages for all distance variables in Panel A, remoteness of a nonmetropolitan county was estimated as increasingly household attractive during the 1990s. Households appeared increasingly willing to accept smaller wage gains or greater wage losses in exchange for greater remoteness. The largest increased productivity disadvantage occurred for the distance from any urban center, while the greatest increased household attractiveness occurred for the incremental distance from the largest metropolitan areas.[16] Cumulatively, slightly less than 80 percent of the distance-based relative wage decline in nonmetropolitan areas is attributable to increasing productivity disadvantages. The household share rose from one percent for greater distance from any urban center to about 37 percent for incremental distances from the top two tiers of the urban hierarchy. On net, households increasingly preferred living in remote areas over being closer to urban amenities.

As shown in Panel B, increasing household net preferences for remoteness play a somewhat larger relative role in relative wage growth in small MA counties compared with nonmetro counties. The results for the distance to the county's *own* MA core indicate that the attractiveness of small MA suburbs increased. The positive sign on the productivity component for greater distance from the core indicates that small MA suburban counties also were (slightly) increasingly more productive relative to their corresponding centers. The household effect share in excess of 100 indicates that positive household remoteness effects exceed the overall nominal

[16]For micropolitan counties only, the distance from any urban center is measured as the center to the core of its micropolitan area. Yet, performing the same regressions and decompositions for rural counties alone produced nearly identical results to those for all nonmetropolitan counties.

wage differential because the positive productivity effect worked to slightly increase wages. Beyond distance to their own centers, the household effect on (negative) wage growth is greatest for incremental distances from the largest MAs, in which it becomes the dominant force underlying the wage growth differential (60%) associated with the incremental distance from the nearest MA over 1.5 million people (and the most negative real wage growth effect). The cumulative household share over all incremental distance variables (excluding the distance to the core of its own MA) is approximately 43%.

The results for suburban counties in large MAs also display their increasing household-attractiveness (Panel C). In contrast to small MAs, there is an associated increasing productivity disadvantage in large MA suburbs relative to their central city areas. The large MA suburban productivity disadvantage may be the result of the increased prominence of high-end services in their central cities. Household net preferences for remoteness also play dominant roles in the lower relative wage gains associated with greater distances from successively higher-tiered MAs. Productivity disadvantages of distance were responsible for only 26% of the relative wage decline in MAs with population between 500 thousand and 1.5 million people for remoteness from MAs with over 1.5 million people.

4.2.2 Sensitivity Analysis

In an attempt to capture additional potential effects associated with the very largest MAs, we also added to the base regressions the incremental distance to New York, Chicago, or Los Angeles (results not shown). For example, increased returns to ideas generated in the largest cities may unevenly spill over to the nation with advances in communications technology (Glaeser and Ponzetto, 2007). However, this variable was insignificant in all regressions except for wage growth (t=-1.90) and housing price growth (t=-3.39) in small MAs. Application of our decomposition methodology reveals firm productivity disadvantages as responsible for 72 percent of this distance-based reduction in relative wage growth.

Because of the use of aggregate wage and housing cost data, the demographic control variables in the wage equation and the housing characteristics in the housing cost equation may be endogenous (Hanson, 2005). Thus, we re-estimated the base equations dropping these control variables, which should remove any potential bias in the remaining regression coefficients. The wage decomposition results based on the re-estimated equations are shown in the first two columns of Table 3. The average estimated relative wage growth shares attributed to changes in household preferences for remoteness versus productivity are remarkably similar to those in Table 2, suggesting the base results are not greatly affected by any potential endogeneity, nor to omitting worker and housing characteristics.[17]

The remaining three sets of decomposition results in Table 3 are based on the regression results presented in Tables 1A and 1B (columns 4-6), but using alternative decompositions. The first set is based on using only the distance variable coefficients which are statistically significant at the 10 percent level or lower. The second set derives from using alternative parameters to calibrate the bracketed term in Equation 7 (see Table 3 notes). And the third set is produced by implementing an alternative price deflator for wages.

From columns 3 and 4 in Table 3, the decomposition for nonmetropolitan areas remains unchanged when using only significant coefficients because all the distance variables are significant in both regressions. However, the insignificance of the incremental distance variable from large metropolitan areas with population over 1.5 million in both MA samples changes their decomposition shares, in which the productivity shares are now estimated to be slightly larger in both sub-samples.

Because the decomposition can be sensitive to the calibration of parameters in the bracketed term in Equation (7), we also decompose the wage growth differential using alternative parameter values for this term from Beeson and Eberts (1989). As seen from columns (5) and (6) of Table 3, the use of these alternative parameters produces slightly greater roles for increased productivity forces. For large metropolitan areas, productivity forces become about equal in importance with household net preferences for remoteness. Yet, the general pattern of increasing

[17]In comparing housing price indices, including a repeat sales index controlling for unmeasured attributes, Shapiro (2006) reports that unmeasured housing characteristics do not greatly affect growth rates in derived implicit prices of land.

productivity disadvantages in remote areas and their increasing household attraction remains.

The final two columns show the results of using an alternative price deflator, which attempts to account for differential changes in regional prices for both local non-housing goods and housing. It may be that prices for non-housing goods and services also became relatively lower in more remote areas during the 1990s. To the extent these changes occurred, and are ignored, overestimates of real wage decreases and of increased household-attractiveness in remote areas would result. Because of an absence of official price data for non-metropolitan areas, we follow Shapiro (2006) and conduct sensitivity analysis using an estimated upper bound for the housing price share to deflate nominal wages.[18]

The decomposition results now change somewhat more substantially. For nonmetropolitan areas, remoteness from the nearest urban center is estimated to have become increasingly household *unattractive*, while little change is now estimated for remoteness from the nearest metropolitan area of any size, and from the nearest metropolitan area with population over 250,000. Remoteness from the larger two tiers of metropolitan areas remains as increasingly household attractive, though by lesser amounts, and overall there is approximately no net change in household net preferences for remoteness in nonmetropolitan counties over the period. For small MAs, only remoteness from metropolitan areas over 500,000 now appears as increasingly attractive to households. The results for large MAs are mostly unchanged. Distance from the largest MAs continue to be estimated as increasingly household attractive, still dominating increased productivity disadvantages in reducing relative wage growth in the MA samples.

4.2.3 Decomposition Summary

Across a variety of specifications, it appears that productivity shocks during the 1990s made it less profitable for firms to locate in nonmetropolitan areas. Hence, while the internet made it

[18]The upper bound is based on the estimated relationship between housing rental costs and the overall price index to account for differences in non-traded goods costs by Shapiro (2006); the combined share is estimated to be 0.32. We view this as an upper bound because it is based on cross-city variation and may overstate the adjustment to the price index required in rural areas. Although housing costs are well known to be lower in rural areas, costs of food and other items could be higher because of transportation and other distance-based delivery costs (Jolliffe, 2006; Nord and Leibtag, 2005), making it less likely that rural non-traded goods prices follow trends in housing prices.

technically possible to live and work in remote locations (Kotkin, 1998), economically it became more costly to do business farther away from larger cities. Such findings are consistent with those who argue that technological change has been complementary to face-to-face and more frequent interaction (Gasper and Glaeser, 1998; Forman et al., 2005; McCann 2007). However, it became increasingly household-attractive to live in nonmetropolitan areas positioned at greater distances from metropolitan areas, particularly from larger metropolitan areas.

For small and medium-sized MAs, there also were offsetting household preference gains from being farther away from the top two tiers of MAs. In some sense, this is inconsistent with those who argue that the largest MAs are increasingly consumer cities and amenity attractive (Glaeser et al., 2001; Adamson et al., 2004). It is consistent though with the findings by Desmet and Fafchamps (2005) that the very largest MAs are losing jobs to intermediate sized urban areas. Our findings suggest this is attributable to a relative increase in net-household attractiveness of intermediate sized areas relative to the largest MAs. The oftentimes divergence of changes in relative household attractiveness versus productivity disadvantages reinforce the findings by Gabriel and Rosenthal (2004) and Chen and Rosenthal (2008) that there is very little if any correlation between the quality of life and the quality of the business environment in MAs.

4.3 Migration Responses

Primarily as confirmatory analysis of the above decomposition, we also examine the patterns of migration across age and education levels within the urban hierarchy. Although recent population growth has been reported as negatively associated with being farther away from larger urban centers (Partridge et al. 2008b), this pattern may not be consistent across age and education cohorts. Chen and Rosenthal (2008) found that younger and more highly-educated households move to more productive places, while those over age 50, regardless of education, move to high amenity places. In tabulation of gross origin-destination migration flows, Plane et al. (2005) similarly reported some population groups moved up the urban hierarchy while others simultaneously moved down.

Table 4 reports the results of estimating Equation (11) by age cohort. The results suggest that those most likely to be economic migrants—the 25-29 age cohort—are generally responding to changes in productivity. Their population shares are falling fastest in (1) nonmetropolitan counties farther away from *any* urban center, (2) in small MA counties that are more remote from MAs with greater than 250,000 people and (3) in large MA counties more distant from MAs with at least 500,000 people. Even *within* MAs, the negative distance-to-own-MA coefficient indicates that young adults are attracted to the central city, which is a pattern that does not apply to older cohorts as they move to the outer suburbs (presumably with children). The relationship between distance and the change in the 30-34 year-old cohort share is somewhat more neutral. Thus, more mobile younger cohorts are generally responding consistent with a pattern of greater productivity growth near larger urban areas (though they also may find individual urban areas differentially attractive).

With some exceptions in the nonmetropolitan and the small MA samples, there are few distance relationships with the 35-39 age cohort share, consistent with fewer economic migrants in this cohort. This pattern intensifies for the 40-49, 50-59, and 60-69 age cohorts with some indication of positive distance effects. Then, for the cohorts that are least responsive to economic signals—70-79 and 80 and over—the results reveal that their shares are positively associated with distance from larger urban areas, suggestive of positive household amenity effects.[19]

Table 5 shows the results for the 1990-2000 change in the college graduate shares (ΔCOLGRAD). For nonmetropolitan counties, the college graduate share declines the further the county is from any urban center. For small MA counties, there are positive linkages for being *closer* to larger MAs, including those over 500,000 people, while for MA counties with population between 250,000 and 500,000 there is also a positive linkage for being closer to an MA with population over 500,000. The college-educated also are less likely to locate in small MA suburban counties but evenly disperse within large MAs.

We re-examined these relationships by re-specifying the model as the change in college graduate shares over the 1980-2000 period, but the empirical patterns were virtually identical,

[19]To test the sensitivity of the age-cohort results, we also re-estimated the results by replacing the respective 1990 housing cost and wage level residuals with actual 1990 wage and a 1990 housing cost levels (not shown); the distance results are virtually unaffected by this change.

illustrating a persistent pattern (not shown). Again, the main finding is that the most economically mobile cohorts are moving toward large MAs (even if not exactly in larger MAs)—even after accounting for potential beginning-period disequilibrium effects.

Overall, the age-cohort migration patterns and movement of college graduates are consistent with the wage growth decomposition results. For nonmetropolitan and small MAs, it is likely that favorable productivity-related shocks in areas closer to larger MAs especially attracted younger and more educated workers. However, the story is more complicated for larger MAs, in which closer distance to cities is linked to favorable productivity shocks, but also negative amenity effects, possibly associated with congestion. Here again, the youth and more educated moved to be closer to larger MAs—consistent with productivity-related effects. Yet, less-educated and older individuals are less-inclined to be closer to larger MAs. These results may help reconcile observations that large cities such as a Boston, New York, or Chicago may appear to be economically vibrant, while on the other hand, growing at relatively slow rates in terms of job and population growth. Not all demographic groups may be benefitting from the economic vibrancy of these areas and are increasingly attracted elsewhere because of quality of life concerns.

5. CONCLUSIONS

This study examined growth differentials in wage rates and housing costs across U.S. counties to assess the changing roles access to urban production externalities versus consumer preferences had in causing remoteness to be associated with poorer economic performance during the 1990s. Remoteness, defined and measured by geographic proximity in the U.S. urban hierarchy, was found to be increasingly associated with lower productivity, contributing to both negative wage and housing cost growth differentials. Yet, remoteness from large metropolitan areas generally became more attractive to households, further contributing to negative wage growth differentials.

Decomposition of wage-growth differentials further revealed that increased productivity disadvantages in areas more remote from higher tiered urban areas dominated any increased household attraction to remoteness in nonmetropolitan and small-MA counties. Changing productivity effects during the period were most related to being closer to the nearest *higher*-tiered urban area (of any size) rather than just being nearer to the *highest*-tiered urban areas. Yet, increased household preferences for remoteness dominated for metropolitan counties in medium-sized MAs in terms of remoteness from even larger MAs. Thus, although we found the opposite of production-based agglomeration shadows, larger MAs increasingly were deemed less attractive to households the closer they were to successively larger metropolitan areas. This runs counter to consumer-city arguments that would favor proximity to largest urban areas. Instead, there were apparently increased household preferences for less-congested smaller urban areas (*ceteris paribus*), possibly supported by changes in technology or preferences that favored consuming leisure activities in smaller urban areas and rural areas.

Analysis of migration patterns through examination of changes in age and education cohort shares over the period confirmed these patterns. Younger and more educated households moved to areas in closer proximity to larger MAs, while older households moved to more remote areas. Future research then should be devoted to identifying the sources of increased productivity disadvantages in remote areas and the sources of increased amenity unattractiveness of large metropolitan areas and whether they will continue. This will be particularly relevant for planning and policy purposes as the U.S. economy evolves technologically and its population ages.

REFERENCES

Adamson, Dwight, David Clark and Mark D. Partridge, 2004. “Do Urban Agglomeration Economies and Amenities Have a Skill Bias?” *Journal of Regional Science* 44(2): 201-224.

Barker, David and Jay Sa-Aadu, 2004. “Is Real Estate Becoming Important Again? A Neo-Ricardian Model of Land Rent,” *Real Estate Economics* 32(1), 33-53.

Barkley, David L., Mark S. Henry, and Shuming Bao, 1996. “Identifying 'Spread' versus 'Backwash' Effects in Regional Economic Areas: A Density Functions Approach,” *Land Economics* 72(3), 336-57.

Beeson, Patricia E. and Randall W. Eberts, 1989. “Identifying Productivity and Amenity Effects in Interurban Wage Differentials,” *Review of Economics and Statistics* 71(3), 443-52.

Black, Duncan and Vernon Henderson. 1999. “Spatial Evolution of Population and Industry in the United States.” *American Economic Review* 89: 321-327.

Blomquist, Glenn, Mark Berger, and John Hoehn, 1988. “New Estimates of the Quality of Life in Urban Areas,” *American Economic Review* 78, 89-107.

Chen, Yong and Stuart Rosenthal. 2008. “Local Amenities and Life Cycle Migration: Do People Move for Jobs or Fun?” *Journal of Urban Economics* 64(3), 519-37.

Clark, D.E., W.E. Herrin, T.A. Knapp and N.E. White. (2003) “Migration and Implicit Amenity Markets: Does Incomplete Compensation Matter?” *Journal of Economic Geography* (3), 289-307.

Combes, Pierre-Philippe and Miren Lafourcade. 2005. “Transport Costs: Measures, Determinants, and Regional Policy Implications for France.” *Journal of Economic Geography* 5, 319–349.

Conley, T.G., 1999. “GMM Estimation with Cross Sectional Dependence,” *Journal of Econometrics* 92, 1-45.

Davis, Morris A. and Francois Ortalo-Magne, 2007. "Household Expenditures, Wages, and Rents." CESifo Working Paper No. 2156.

Davis, Morris A. and Michael G. Palumbo, 2008. “The Price of Residential Land in Large U.S. Cities,” *Journal of Urban Economics* 63(1), pp. 352-84.

Desmet, Klaus, and Marcel Fafchamps, 2005. “Changes in the Spatial Concentration of Employment across US Counties: A Sectoral Analysis 1972-2000,” *Journal of Economic Geography* 5(3), 261-84.

Dumais, Guy, Glenn Ellison, and Edward L. Glaeser. 2002 “Geographic Concentration as a Dynamic Process,” *Review of Economics and Statistics* 84: 193-204.

Eeckhout, Jan. 2004. “Gibrat’s Law for (All) Cities.” *American Economic Review,* 94: 1429-1451.

Forman, Chris, Avi Goldfarb, and Shane Greenstein. 2005. “How Did Location Affect Adoption of the Commercial Internet? Global Village, Urban Density, and Industry Composition,” *Journal of Urban Economics*, 58(3), 389-420.

Gabriel, Stuart A., Joe P. Mattey and William L.Wascher, 2003. “Compensating Differentials and Evolution in the Quality-of-Life among U.S. States,” *Regional Science and Urban Economics* 33(5), 619-649.

Gabriel, Stuart A. and Stuart S. Rosenthal, 2004. “Quality of the Business Environment versus Quality of Life: Do Firms and Households Like the Same Cities?” *Review of Economics and Statistics* 86(1), 438-444.

Gasper, J., and Edward L. Glaeser. 1998. “Information Technology and the Future of Cities.” *Journal of Urban Economics* 43: 136–156.

Glaeser, Edward L., Joseph Gyourko and Raven Saks, 2006. “Urban Growth and Housing Supply,” *Journal of Economic Geography* 6(1), 71-89.

Glaeser, Edward L, J. Kolko and A. Saiz A. 2001. Consumer City. *Journal of Economic Geograp*hy 1: 27-50.

Glaeser, Edward L. and Giacomo A.M. Ponzetto, 2007. “Did the Death of Distance Hurt Detroit and Help New York?” National Bureau of Economic Research Working Paper 13710.

Glaeser, Edward L., Shapiro, Jesse M., 2003. "Urban Growth in the 1990s: Is City Living Back?" *Journal of Regional Science* 43(1), pp. 139-65.

Glaeser, Edward L. and Kristina Tobio, 2008. "The Rise of the Sunbelt," *Southern Economic Journal*, 74(3), pp. 610-43.

Graves, Philip E., and Peter R. Mueser, 1993. "The Role of Equilibrium and Disequilibrium in Modeling Regional Growth and Decline: A Critical Reassessment," *Journal of Regional Science* 33, 69-84.

Hanson, Gordon H., 2005. "Market Potential, Increasing Returns and Geographic Concentration," *Journal of International Economics* 67, 1-24.

Head, Keith and Thierry Mayer, 2004. "The Empirics of Agglomeration and Trade," in Handbook of Regional and Urban Economics, Vol. 4, pp. 2609-69, Eds. (J.V. Henderson and J.F. Thisse). Elsevier: San Diego. Accessed at http://strategy.sauder.ubc.ca/head/Papers/neat.pdf.

_____, 2006. "Regional Wage and Employment Responses to Market Potential in the EU," *Regional Science and Urban Economics* 36, 573-594.

Jolliffe Dean, 2006. "Adjusting for Living Costs Can Change Who is Considered Poor," *Amber Waves*, available at http://www.ers.usda.gov/AmberWaves/November06/.

Knaap, Thijs, 2006. "Trade, location, and wages in the United States," *Regional Science and Urban Economics* 36, 595-612.

Kotkin, Joel, "Why Wall Street is Losing Out to Forty Acres and a Modem?" New York Times (December 27, 1998).

McCann, Philip, 2007. "Sketching Out a Model of Innovation, Face-to-face Interaction and Economic Geography." *Spatial Economic Analysis* 2(2), 117-34.

_____, 2008. "Globalization and Economic Geography: The World is Curved, Not Flat," *Cambridge Journal of Regions, Economy, and Society* 1(3), 351-370.

Nord, Mark and Ephraim Leibtag, 2005." Is the 'Cost of Enough Food' Lower in Rural Areas?" *The Review of Regional Studies*, 35, 291-310.

Ottaviano, Gianmarco and Dino Pinelli, 2006. "Market Potential and Productivity: Evidence from Finnish Regions," *Regional Science and Urban Economics* 36, 636-657.

Partridge, Mark D., Dan S. Rickman, Kamar Ali and M. Rose Olfert. 2008a. "Employment Growth in the American Urban Hierarchy: Long Live Distance." *The B.E. Journal of Macroeconomics* (*Contributions*) 8(Issue 1). Available at: http://www.bepress.com/bejm/vol8/iss1/art10.

_____. 2008b. "Lost in Space: Population Dynamics in the American Hinterlands and Small Cities." *Journal of Economic Geography* 8(6), 727-757.

_____. 2009. "Agglomeration Spillovers and Wage and Housing Cost Gradients across the Urban Hierarchy," *Journal of International Economics* 78(1), 126-140.

Peiser, Richard B. and Lawrence B. Smith, 1985. "Homeownership Returns, Tenure Choice and

Inflation," *American Real Estate and Urban Economics Association Journal* 13(4), 343-360.

Plane, D.A, C.J. Henrie and M.J. Perry, 2005. "Migration Up and Down the Urban Hierarchy and across the Life Course," *Proceedings of the National Academy of Sciences* 102(43), 15313-15318.

Polèse, Mario and Richard Shearmur, 2004. "Is Distance Really Dead? Comparing Industrial Location Patterns Over Time in Canada," *International Regional Science Review* 27(4), 431-457.

Rappaport, Jordan and Jeffrey Sachs, 2003. "The United States as a Coastal Nation," *Journal of Economic Growth* 8(1), 5-46.

Redding, S. and A. Venables, 2004. "Economic Geography and International Inequality," *Journal of International Economics* 62(1), 53-82.

Rietveld, Piet and Roger Vickerman, 2004. "Transport in Regional Science: The Death of Distance is Premature," *Papers in Regional Science* 83, 229-243.

Roback, J., 1982. "Wages, Rents, and the Quality of Life," *Journal of Political Economy,* 90, 1257-1278.

Shapiro, Jesse M., 2006. "Smart Cities: Quality of Life, Productivity, and the Growth Effects of Human Capital." *The Review of Economics and Statistics* 88, 324-335.

Sinai, Todd and Joel Waldfogel, 2004. "Geography and the Internet: Is the Internet a Substitute or a Complement for Cities?" *Journal of Urban Economics* 56, 1-24.

Tabuchi, Takatoshi and Jacques-François Thisse. 2006. "Regional Specialization, Urban Hierarchy, and Commuting Costs." *International Economic Review* 47: 1295-1317.

U.S. Census Bureau, 2005. *Population Change in Metropolitan and Micropolitan Statistical Areas: 1990–2003,* http://www.census.gov/prod/2005pubs/p25-1134.pdf, last accessed September 8, 2008.

U.S. Census Bureau, 2009. "State Population Estimates and Demographic Components of Population Change: 1990 to 1999," http://www.census.gov/popest/archives/1990s/.

Figure 1. Illustration of Distance Penalties on Equilibrium Wages and Rents

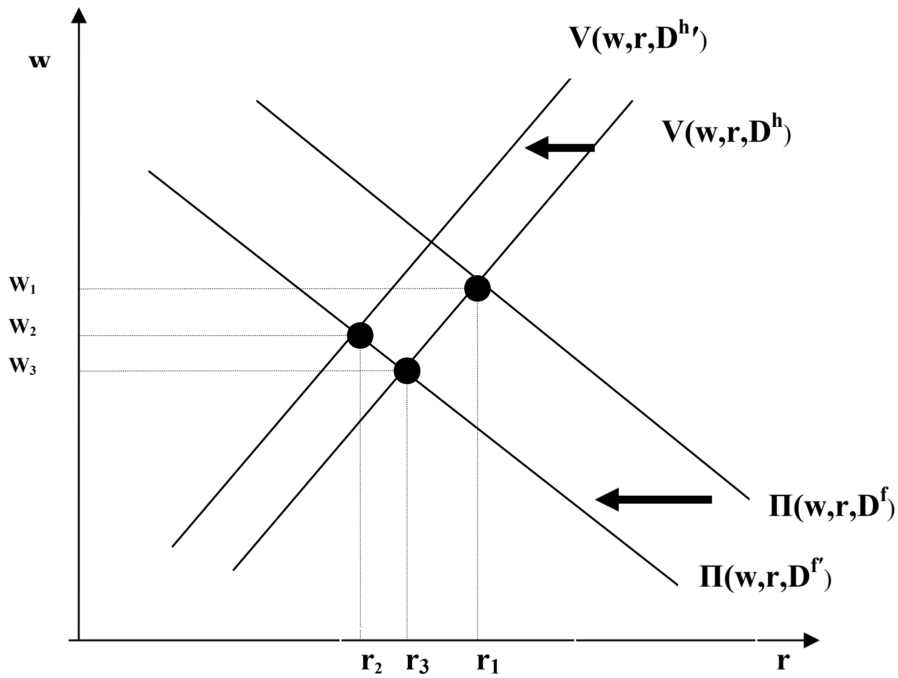

Table 1A: Dependent variable: Log difference of 2000 and 1990 average wage per job in $

	Without 1980 wage			With 1980 wage		
Variables	Non-metro	Small MA≤250k	Large MA>250k	Non-metro	Small MA≤250k	Large MA>250k
Dist to nearest urban center	-1.1E-04	n.a.	n.a.	-1.8E-04**	n.a.	n.a.
	(-1.34)			(-2.86)		
Dist to the center of own metro	n.a.	1.7E-04	8.6E-05	n.a.	-2.8E-05	-3.5E-04*
		(0.61)	(0.40)		(-0.10)	(-1.75)
Inc dist to a MA	-1.3E-04**	n.a.	n.a.	-1.5E-04***	n.a.	n.a.
	(-2.40)			(-3.05)		
Inc dist to MA>250k	-1.3E-04***	-1.3E-04**	n.a.	-1.1E-04***	-1.4E-04**	n.a.
	(-3.48)	(-2.22)		(-3.20)	(-2.61)	
Inc dist to MA>500k	-1.3E-04**	-9.7E-05*	-1.2E-04*	-1.2E-04***	-1.5E-04**	-1.5E-04**
	(-2.88)	(-1.65)	(-1.95)	(-3.36)	(-2.88)	(-2.95)
Inc dist to MA>1500k	-2.3E-05	-4.7E-05	-1.9E-05	-4.6E-05*	-6.5E-05	-5.0E-05
	(-0.75)	(-0.90)	(-0.39)	(-1.72)	(-1.34)	(-1.10)
Market potential within 100-200 km 1989	-6.0E-08	-1.6E-07	-1.4E-07**	-1.1E-07*	-1.8E-07	-1.9E-07**
	(-1.06)	(-1.32)	(-1.97)	(-1.93)	(-1.64)	(-2.90)
Market potential within 200-300 km 1989	-1.4E-08	-2.2E-08	2.1E-08	-4.9E-08	-1.9E-08	3.1E-08
	(-0.39)	(-0.26)	(0.31)	(-1.64)	(-0.23)	(0.53)
Market potential within 300-400 km 1989	5.2E-08	1.4E-08	-8.1E-08	4.3E-08	-1.2E-08	-5.7E-08
	(1.25)	(0.18)	(-1.44)	(1.11)	(-0.15)	(-1.05)
Market potential within 400-500 km 1989	-6.0E-08*	-4.8E-08	-3.4E-08	-6.4E-08**	-5.6E-08	-4.6E-08
	(-1.67)	(-0.84)	(-0.47)	(-2.07)	(-1.08)	(-0.74)
County Population 1990	-2.7E-07*	-3.7E-08	-5.2E-11	1.4E-07	5.7E-08	3.4E-09
	(-1.94)	(-0.60)	(-0.01)	(1.20)	(1.04)	(0.41)
Pop of nearest/actual urban center 1990	-2.2E-08	1.6E-07**	-1.2E-09	-2.0E-08	1.2E-07*	-4.6E-10
	(-1.05)	(2.11)	(-0.67)	(-1.23)	(1.65)	(-0.33)
Log(average wage 1980)	n.a.	n.a.	n.a.	-0.216***	-0.147***	-0.198***
				(-11.29)	(-5.87)	(-8.47)
Adj. R^2	0.24	0.28	0.28	0.35	0.35	0.36
Sample size	1972	416	640	1972	416	640
Distance penalties (%)	-2.08	-1.55	-0.42	-3.14	-1.80	-0.54
F-stats: All distance vars = 0	4.56***	1.55	1.21	5.03***	1.83	1.41
Incremental dist = 0	5.62***	1.26	1.18	5.77***	2.11*	2.09
Market potentials = 0	1.42	0.65	0.97	2.52**	0.88	1.68

Notes: Robust t-statistics following Conley (1999) are in parentheses. ***, **, and * indicate significant at 1%, 5%, and 10% respectively. For variable descriptions, see text and Appendix Table 1. All models further include an intercept, 5 ethnicity shares, 6 age-distribution shares, 4 education shares, % females, % married, % with a work disability measured in 1990, plus an industry mix employment growth variable over 1990-2000, county area, Jan sun hours, Jan temp, July humidity, July temp; USDA topography score, % water area, three indicators for being within 50kms of one of the Great Lakes, Pacific Ocean, and Atlantic Ocean and state fixed effects. Distance penalties are calculated as 100*(exp(sum of sig coeff x mean dist)-1).

Table 1B: Dependent variable: Log difference of 2000 and 1990 weighted average median rent for 2-bedroom houses ($/month)

	Without 1980 rent			With 1980 rent		
Variables	Non-metro	Small MA≤250k	Large MA>250k	Non-metro	Small MA≤250k	Large MA>250k
Dist to nearest urban center	-7.2E-04***	n.a.	n.a.	-7.6E-04***	n.a.	n.a.
	(-6.38)			(-6.86)		
Dist to the center of own metro	n.a.	2.4E-04	3.3E-04	n.a.	7.4E-05	3.5E-04
		(0.76)	(1.11)		(0.22)	(1.12)
Inc dist to a MA	-4.0E-04***	n.a.	n.a.	-4.0E-04***	n.a.	n.a.
	(-4.93)			(-4.95)		
Inc dist to MA>250k	-3.8E-04***	-4.0E-04***	n.a.	-3.8E-04***	-4.0E-04***	n.a.
	(-7.72)	(-5.83)		(-7.68)	(-5.96)	
Inc dist to MA>500k	-2.3E-04***	-1.4E-04*	-4.9E-05	-2.3E-04***	-1.5E-04**	-4.4E-05
	(-3.55)	(-1.73)	(-0.49)	(-3.65)	(-2.10)	(-0.44)
Inc dist to MA>1500k	-8.2E-05*	-2.2E-06	3.1E-05	-8.5E-05*	-2.1E-05	3.3E-05
	(-1.73)	(-0.04)	(0.54)	(-1.83)	(-0.35)	(0.58)
Market potential within 100-200 km 1989	-7.2E-07***	-3.8E-07***	-4.4E-07***	-6.6E-07**	-4.0E-07***	-4.3E-07***
	(-3.30)	(-3.74)	(-5.12)	(-2.92)	(-4.25)	(-5.20)
Market potential within 200-300 km 1989	4.8E-08*	-1.7E-07**	-2.0E-07*	5.0E-08**	-1.9E-07**	-2.0E-07*
	(1.92)	(-2.68)	(-1.93)	(1.99)	(-2.85)	(-1.92)
Market potential within 300-400 km 1989	-3.3E-07**	-2.3E-07**	-3.2E-07**	-3.3E-07**	-2.3E-07**	-3.2E-07**
	(-2.64)	(-2.71)	(-3.17)	(-2.63)	(-2.85)	(-3.17)
Market potential within 400-500 km 1989	-6.1E-08	-8.6E-08	-1.9E-08	-6.7E-08	-9.4E-08	-1.8E-08
	(-0.96)	(-1.31)	(-0.26)	(-1.05)	(-1.43)	(-0.25)
County Population 1990	4.8E-08	-2.3E-07***	-1.7E-08**	5.0E-08	-2.3E-07***	-1.6E-08**
	(0.78)	(-4.06)	(-2.01)	(0.79)	(-4.30)	(-1.99)
Pop of nearest/actual urban center 1990	-6.8E-10	8.3E-08	1.6E-09	-6.9E-10	8.3E-08	1.4E-09
	(-0.01)	(0.97)	(1.02)	(-0.01)	(0.99)	(0.79)
Log(weighted average median rent 1980)	n.a.	n.a.	n.a.	-0.038*	-0.070**	0.014
				(-1.77)	(-2.14)	(0.42)
Adj. R^2	0.62	0.77	0.80	0.62	0.77	0.80
Sample size	1972	416	640	1972	416	640
Distance penalties (%)	-8.97	-4.16	0	-9.20	-4.23	0
F-stats: All distance vars = 0	33.91***	10.73***	1.35	35.19***	9.57***	1.36
Incremental dist = 0	31.79***	9.53***	0.67	32.41***	9.64***	0.65
Market potentials = 0	8.20***	3.95***	11.07***	8.41***	4.31***	10.88***

Notes: Robust t-statistics following Conley (1999) are in parentheses. ***, **, and * indicate significant at 1%, 5%, and 10% respectively. For variable descriptions, see text and Appendix Table 1. All models further include an intercept, age of housing units, shares of 1-5 bedrooms, share of mobile units, share of complete plumbing and share of complete kitchen facilities measured in 1990, plus an industry mix employment growth variable over 1990-2000, county area, Jan sun hours, Jan temp, July humidity, July temp; USDA topography score, % water area, three indicators for being located within 50kms of one of the Great Lakes, Pacific Ocean, and Atlantic Ocean, and state fixed effects. Distance penalties are calculated as 100*(exp(sum of sig coeff x mean dist)-1).

Table 2. Decomposition of Distance-Based Differentials in Wage Growth

Panel A	Nonmetropolitan Counties						
Variable	Inc. Distance	Nominal Wage	Real Wage	Amenity Component	Productivity Component	Amenity Share (%)	Productivity Share (%)
Dist. nearest/actual UC	41.07	-7.27E-03	-1.02E-04	-6.54E-05	-7.20E-03	0.90	99.10
Incremental dist metro	55.40	-8.20E-03	-3.09E-03	-1.98E-03	-6.22E-03	24.18	75.82
Inc. dist. metro > 250K	66.80	-7.25E-03	-1.38E-03	-8.83E-04	-6.37E-03	12.18	87.82
Inc. dist. metro > 500K	42.89	-5.18E-03	-2.88E-03	-1.85E-03	-3.34E-03	35.63	64.37
Inc. dist. metro > 1.5 mill.	89.03	-4.05E-03	-2.31E-03	-1.48E-03	-2.57E-03	36.57	63.43
Cumulative/Average	**295.19**	**-3.19E-02**	**-9.76E-03**	**-6.26E-03**	**-2.57E-02**	**21.89**	**78.11**
Panel B	Small Metropolitan Counties						
Dist. nearest/actual UC	17.76	-4.97E-04	-7.97E-04	-5.11E-04	1.41E-05	102.83	-2.83
Incremental dist metro							
Inc. dist. metro > 250K	93.23	-1.28E-02	-4.16E-03	-2.67E-03	-1.01E-02	20.86	79.14
Inc. dist. metro > 500K	36.87	-5.39E-03	-4.07E-03	-2.61E-03	-2.77E-03	48.51	51.49
Inc. dist. metro > 1.5 mill.	78.54	-5.14E-03	-4.77E-03	-3.06E-03	-2.08E-03	59.52	40.48
Cumulative/Average	**208.64**	**-2.33E-02**	**-1.30E-02**	**-8.34E-03**	**-1.50E-02**	**42.96**	**57.04**
Panel C	Large Metropolitan Counties						
Dist. nearest/actual UC	28.6	-1.01E-02	-1.23E-02	-7.92E-03	-2.15E-03	78.66	21.34
Incremental dist metro							
Inc. dist. metro > 250K							
Inc. dist. metro > 500K	36.29	-5.42E-03	-5.05E-03	-3.24E-03	-2.18E-03	59.77	40.23
Inc. dist. metro > 1.5 mill.	99.37	-4.94E-03	-5.70E-03	-3.65E-03	-1.28E-03	73.99	26.01
Cumulative/Average	**135.66**	**-1.04E-02**	**-1.07E-02**	**-6.89E-03**	**-3.46E-03**	**66.88**	**33.12**

Notes: Column 1 reports the incremental distance in kilometers between the county and the closest county in the corresponding higher tier; Column 2 is the product of the corresponding estimated wage growth differential per kilometer in Table 1A and the incremental distance in kilometers (because of rounding in the reported results in Table 1A, the Table 2 results cannot be calculated by the reader); Column 3 is the calculated real wage effect, corresponding to the second term in Equation (7). Column 4 contains the calculated amenity component according to Equation (7)—i.e., the portion of the Column 2 wage growth differential attributable to the household amenity effect. Column 5 contains the portion of the wage growth differential attributable to the productivity effect, which is obtained by subtracting the Column 4 entry from the Column 2 entry. Columns 6 and 7 contain the results of dividing the Column 4 and 5 entries by the nominal wage growth differential in Column 2, producing the household shares of the wage growth differential attributable to increased household amenity attractiveness and reduced productivity, respectively. Percentage effects can be obtained for the Column 2-5 results by multiplying by 100.

Panel A	Nonmetropolitan Counties			
	Omitting Characteristics Variables	Use of Significant Coefficients Only	Alternative Bracketed Term in Equation (7)	Alternative Regional Price Deflator

Variable	Amenity Share (%)	Prod. Share (%)	Amenity Share (%)	Prod. Share (%)	Amenity Share (%)	Prod. Share (%)	Amenity Share (%)	Prod. Share(%)
Dist. nearest/actual UC	5.59	94.41	0.90	99.10	0.69	99.31	-23.92	123.92
Incremental dist metro	26.18	73.82	24.18	75.82	18.42	81.58	8.50	91.50
Inc. dist. metro > 250K	17.21	82.79	12.18	87.82	9.28	90.72	-8.22	108.22
Inc. dist. metro > 500K	35.61	64.39	35.63	64.37	27.14	72.86	24.43	75.57
Inc. dist. metro > 1.5 mill.	39.50	60.50	36.57	63.43	27.86	72.14	25.75	74.25
Cumulative/Average	**24.82**	**75.18**	**21.89**	**78.11**	**16.68**	**83.32**	**5.31**	**94.69**
Panel B	Small Metropolitan Counties							
Dist. nearest/actual UC	102.59	-2.59	102.83	-2.83	78.33	21.67	118.02	-18.02
Incremental dist metro								
Inc. dist. metro > 250K	33.09	66.91	20.86	79.14	15.89	84.11	3.87	96.13
Inc. dist. metro > 500K	48.89	51.11	48.51	51.49	36.96	63.04	42.38	57.62
Inc. dist. metro > 1.5 mill.	65.58	34.42			45.34	54.66	57.71	42.29
Cumulative/Average	**49.19**	**50.81**	**34.69**	**65.31**	**32.73**	**67.27**	**34.65**	**65.35**
Panel C	Large Metropolitan Counties							
Dist. nearest/actual UC	81.71	18.29	78.66	21.38	59.92	40.08	84.36	15.64
Incremental dist metro								
Inc. dist. metro > 250K								
Inc. dist. metro > 500K	65.71	34.29	64.14	35.86	45.53	54.47	58.05	41.95
Inc. dist. metro > 1.5 mill.	74.29	25.71			56.36	43.64	77.85	22.15
Cumulative/Average	**70.00**	**30.00**	**64.14**	**35.86**	**50.95**	**49.06**	**67.95**	**32.05**

Table 3. Wage Growth Decomposition Sensitivity Analysis

Notes: The first set of decomposition shares reflects estimated equations which omit demographic variables in the wage equation and housing characteristics in the housing cost equation to avoid potential endogeneity. The second set is based on only using the distance variable coefficients which are statistically significant at the 10 percent level or lower. The third set derives from using alternative parameters to calibrate Equation 7; based on parameters used by Beeson and Eberts (1989), the bracketed term is implied to equal 0.4886 instead of our estimate of 0.6414. The final set is based on an alternative regional price adjustment of wages to reflect differences in non-traded good costs, with the weight on housing prices equal to 0.32 (Shapiro, 2006).

Table 4: Dependent variables: Changes in age cohort shares over 1990-2000

Variables	Non-metro	Small MA≤250k	Large MA>250k	Non-metro	Small MA≤250k	Large MA>250k
	Cohort 25-29 years			**Cohort 50-59 years**		
Intercept	8.932 (1.62)*	-0.405 (-0.05)	1.745 (0.45)	-17.394 (-1.03)	-9.979 (-1.70)*	-2.455 (-0.88)
Dist to nearest urban center	-3.8E-03 (-2.06)**	n.a.	n.a.	1.5E-02 (1.78)*	n.a.	n.a.
Dist to the center of own metro	n.a.	-1.5E-02 (-2.50)**	-2.3E-02 (-4.44)***	n.a.	7.3E-03 (1.61)	6.3E-03 (1.75)*

Inc dist to a MA	6.1E-04 (0.68)	n.a.	n.a.	2.1E-03 (0.84)	n.a.	n.a.
Inc dist to MA>250k	-4.8E-04 (-0.4)	-3.6E-03 (-2.36)**	n.a.	2.5E-05 (0.01)	1.7E-03 (1.45)	n.a.
Inc dist to MA>500k	1.8E-03 (1.07)	5.9E-04 (0.37)	-3.8E-03 (-3.33)***	4.7E-03 (0.86)	2.4E-03 (1.56)	2.5E-03 (2.08)**
Inc dist to MA>1500k	2.7E-04 (0.42)	-1.7E-04- (0.18)	-1.8E-03 (-2.13)**	4.1E-04 (0.21)	-6.3E-04 (-0.76)	4.9E-04 (0.57)
	Cohort 30-34 years			**Cohort 60-69 years**		
Intercept	-4.862 (-3.63)***	-5.357 (-1.92)*	0.011 (0.01)	-13.571 (-0.93)	-19.427 (-2.58)**	-1.847 (-0.66)
Dist to nearest urban center	-2.0E-03 (-2.43)**	n.a.	n.a.	1.4E-02 (1.98)**	n.a.	n.a.
Dist to the center of own metro	n.a.	-3.7E-04 (-0.14)	4.7E-03 (1.96)**	n.a.	2.9E-03 (0.51)	9.8E-03 (3.07)**
Inc dist to a MA	-2.5E-04 (-0.47)	n.a.	n.a.	1.3E-03 (0.60)	n.a.	n.a.
Inc dist to MA>250k	-2.1E-04 (-0.47)	-2.3E-03 (-2.86)**	n.a.	-1.1E-03 (-0.58)	3.4E-04 (0.21)	n.a.
Inc dist to MA>500k	5.4E-05 (0.13)	-2.4E-03 (-3.49)***	-4.1E-04 (-0.69)	3.4E-03 (0.69)	1.6E-03 (0.75)	2.4E-03 (2.08)**
Inc dist to MA>1500k	-3.6E-04 (-1.12)	-4.5E-04 (-0.72)	-2.5E-04 (-0.62)	1.5E-04 (0.08)	-3.9E-04 (-0.34)	-2.4E-04 (-0.29)
	Cohort 35-39 years			**Cohort 70-79 years**		
Intercept	-2.935 (-1.97)**	-3.185 (-1.15)	-5.826 (-2.66)**	-2.613 (-1.70)*	-0.757 (-0.38)	-1.742 (-0.95)
Dist to nearest urban center	-3.2E-04 (-0.36)	n.a.	n.a.	3.3E-03 (3.30)***	n.a.	n.a.
Dist to the center of own metro	n.a.	7.6E-03 (2.37)**	4.8E-03 (2.44)**	n.a.	-5.9E-03 (-1.96)**	6.3E-05 (0.03)
Inc dist to a MA	-1.1E-03 (-1.73)*	n.a.	n.a.	1.8E-03 (2.99)**	n.a.	n.a.
Inc dist to MA>250k	-1.1E-03 (-1.98)**	-1.5E-03 (-1.90)*	n.a.	1.5E-03 (3.11)**	2.1E-03 (3.16)**	n.a.
Inc dist to MA>500k	-3.0E-04 (-0.70)	-3.8E-04 (-0.55)	-3.0E-04 (-0.62)	6.9E-04 (1.27)	1.2E-04 (0.18)	1.0E-03 (2.09)**
Inc dist to MA>1500k	1.3E-05 (0.04)	-2.9E-06 (0)	-6.4E-04 (-1.52)	2.1E-04 (0.55)	7.2E-05 (0.15)	7.7E-04 (2.38)**
	Cohort 40-49 years			**Cohort 80 + years**		
Intercept	-24.859 (-1.36)	-26.580 (-3.68)***	-13.052 (-3.34)***	10.454 (3.46)***	10.342 (2.53)**	4.811 (0.87)
Dist to nearest urban center	1.4E-02 (1.64)	n.a.	n.a.	-3.0E-04 (-0.16)	n.a.	n.a.
Dist to the center of own metro	n.a.	9.3E-03 (1.86)*	1.1E-02 (2.93)**	n.a.	-1.2E-02 (-2.21)**	-5.6E-03 (-1.22)
Inc dist to a MA	2.1E-03 (0.81)	n.a.	n.a.	3.3E-03 (2.83)**	n.a.	n.a.
Inc dist to MA>250k	9.8E-04 (0.47)	-6.6E-04 (-0.46)	n.a.	3.6E-03 (4.09)***	2.2E-03 (1.61)	n.a.
Inc dist to MA>500k	6.0E-03 (1.04)	2.2E-03 (1.14)	2.4E-03 (2.57)**	1.7E-03 (1.88)*	2.0E-03 (1.29)	4.3E-04 (0.23)
Inc dist to MA>1500k	1.3E-03 (0.61)	-7.2E-04 (-0.75)	7.1E-04 (1.21)	2.3E-03 (3.60)***	1.6E-03 (1.54)	2.0E-03 (2.03)**

Notes: Robust t-statistics from STATA cluster command are in parentheses. ***, **, and * indicate significant at 1%, 5%, and 10% respectively. All models further include 4 market potential variables, 5 ethnicity shares, 4 education shares, % females, % married, % with a work disability – measured in 1990, county area, Jan sun hours, Jan temp, July humidity, July temp; USDA topography score, % water area, three indicators for being located within 50kms of one of the Great Lakes, Pacific Ocean, and Atlantic Ocean, state fixed effects, plus residuals from two first-stage regressions that used log(wage90) and log(rent90) as dependent variables. These 1990 wage and rent models used similar variables described above except that the market potential variables were for 1980, included log(wage80) or log(rent80) as additional controls plus house characteristics variables (age, bedrooms, plumbing, kitchen) in the rent model.

Table 5: Dependent variable: Change in college grad shares over 1990-2000

Variables	Non-metro	Small MA≤250k	Large MA>250k
Intercept	3.561	-10.671*	4.840
	(1.25)	(-1.73)	(1.05)
Dist to nearest urban center	-3.9E-03	n.a.	n.a.
	(-1.99)**		
Dist to the center of own metro	n.a.	-1.0E-02*	-2.0E-03
		(-1.90)	(-0.36)
Inc dist to a MA	-1.2E-03	n.a.	n.a.
	(-0.83)		
Inc dist to MA>250k	-4.8E-04	-5.0E-03**	n.a.
	(-0.51)	(-2.61)	
Inc dist to MA>500k	-1.1E-03	-3.9E-03**	-3.9E-03***
	(-1.09)	(-2.06)	(-3.06)
Inc dist to MA>1500k	-2.2E-04	-1.2E-03	4.0E-04
	(-0.32)	(-0.71)	(0.41)
Market potential within 100-200 km 1989	-4.3E-07	-3.5E-06	-3.3E-06**
	(-0.34)	(-1.14)	(-2.06)
Market potential within 200-300 km 1989	-1.7E-06**	4.3E-07	-1.7E-06
	(-2.00)	(0.22)	(-1.03)
Market potential within 300-400 km 1989	6.6E-08	-2.6E-07	-2.4E-06
	(0.08)	(-0.14)	(-1.82)
Market potential within 400-500 km 1989	-1.1E-06	4.6E-07	-1.7E-06
	(-1.34)	(0.23)	(-1.41)
County Population 1990	-1.1E-06	3.2E-07	-1.5E-07
	(-0.46)	(0.19)	(-1.55)
Pop of nearest/actual urban center 1990	5.3E-07	6.7E-07	6.0E-08*
	(0.89)	(0.34)	(1.94)
Residuals from log(average wage 1990)	-0.651	1.208	-0.530
	(-0.96)	(0.83)	(-0.67)
Residuals from log(wtd ave med rent 1990)	3.544***	5.551***	5.395***
	(6.70)	(3.82)	(4.94)
Amenities/Ocean	Y	Y	Y
R^2	0.25	0.50	0.54
Sample size	1972	416	640
F-stats			
All distance vars = 0	1.06	2.23*	4.95***
Incremental dist = 0	0.41	2.76**	7.43***
Market potentials = 0	1.83	0.62	1.84
Resisuals = 0	23.10***	7.31***	12.31***

Notes: Robust t-statistics from STATA cluster command are in parentheses. ***, **, and * indicate significant at 1%, 5%, and 10% respectively. Y=included. For variable descriptions, see text and Appendix Table 1. All models further include 5 ethnicity shares, 4 education shares, % females, % married, % with a work disability – measured in 1990, plus county area (in square miles), and state fixed effects. Amenities/Ocean variables include Jan sun hours, Jan temp, July humidity, July temp; USDA topography score, % water area, and three indicators for being located within 50kms of one of the Great Lakes, Pacific Ocean, and Atlantic Ocean.

Appendix Table 1. Variable Definitions and Descriptive Statistics (full sample)

Variable	Description	Source	Mean	St. dev.
Dependent Variables				
log(av wage 2000) – log(av wage 1990)	Log difference of 2000 and 1990 average wage per job (in dollars).	BEA, REIS	0.35	0.09
log(wtd av med rent 2000) – log(wtd av med rent 1990)	Log difference of 2000 and 1990 weighted average median gross house rent (dollars per month) of owner and renter occupied housing units. For owner occupied units, imputed annual rent is calculated as 7.85% of median house value. Monthly average of that amount along with the median monthly rent for the renter occupied units are used to calculate the weighted average median rent, with weights being the shares of owner and renter occupied houses. Note that there are no official U.S. cost of living data series (in levels) at even the state level—let alone at the county level.	Census	0.43	0.14
Cohort 25-29 share change over 1990-2000	Difference between shares of 25-29 years 2000 population and 15-19 years 1990 population.	Census	-1.58	1.46
Cohort 30-34 share change over 1990-2000	Difference between shares of 30-34 years 2000 population and 20-24 years 1990 population.	Census	-0.99	0.88
Cohort 35-39 share change over 1990-2000	Difference between shares of 35-39 years 2000 population and 25-29 years 1990 population.	Census	-0.33	0.88
Cohort 40-49 share change over 1990-2000	Difference between shares of 40-49 years 2000 population and 30-39 years 1990 population.	Census	-0.38	1.51
Cohort 50-59 share change over 1990-2000	Difference between shares of 50-59 years 2000 population and 40-49 years 1990 population.	Census	-0.65	1.41
Cohort 60-69 share change over 1990-2000	Difference between shares of 60-69 years 2000 population and 50-59 years 1990 population.	Census	-0.78	1.33
Cohort 70-79 share change over 1990-2000	Difference between shares of 70-79 years 2000 population and 60-69 years 1990 population.	Census	-2.51	0.95
Cohort 80 + share change over 1990-2000	Difference between shares of 80 + years 2000 population and 70 + years 1990 population.	Census	-6.37	2.05
College grad share change over 1990-2000	Difference between 4-year college grad shares of 25+ years population over 2000 and 1990.	Census	2.99	2.13
Distance variables				
Dist to nearest/actual urban center (micropolitan or metropolitan area, CBSA)	Distance (in km) between centroid of a county and population weighted centroid of the nearest urban center, if the county is not in an urban center. It is the distance to the centroid of its own urban center if the county is a member of an urban center (in kms).	C-RERL	34.61	32.44
Inc dist to a metro	Incremental distance to the nearest/actual metropolitan area in kms (see text for details)	Authors' est.	36.68	49.06
Inc dist to metro>250k	Incremental distance to the nearest/actual metropolitan area with at least 250,000 population in 1990 in kms (see text for details)	Authors' est.	56.29	97.27
Inc dist to metro>500k	Incremental distance to the nearest/actual metropolitan area with at least 500,000 population in 1990 in kms (see text for details)	Authors' est.	40.67	66.83
Inc dist to metro>1500k	Incremental distance to the nearest/actual metropolitan area with at least 1,500,000 population in 1990 in kms (see text for details)	Authors' est.	89.77	111.47
Amenity/Ocean				
January Sun hours	Mean January sun hours	ERS, USDA	151.41	33.21
January temp	Mean January temperature (degree F)	ERS, USDA	32.95	12.07
July humidity	Mean July relative humidity (%)	ERS, USDA	56.15	14.49
July temp	Mean July temperature (degree F)	ERS, USDA	75.90	5.35
Topography Measure	A 1 to 24 score. 24 reflects the most mountainous terrain	ERS, USDA	8.83	6.59
Percent water	Percent of county area covered by water	ERS, USDA	4.61	11.29
Proximity to Great Lakes	1 if county centroid is within 50km of Great Lakes	Authors' est.	0.04	0.19
Proximity to Pacific Ocean	1 if county centroid is within 50km of Pacific Ocean	Authors' est.	0.02	0.13
Proximity to Atlantic Ocean	1 if county centroid is within 50km of Atlantic Ocean	Authors' est.	0.08	0.28
County area	County area in square miles	ERS, USDA	1011.13	1331.87
Market Potential Economic				
Agg hh inc within 100-200	Aggregate household income between 100 and 200 km	1990 Census,	48687.36	58938.66

km ring 1989 (mill.$)	radii from county centroid	Authors' est.		
Agg hh inc within 200-300 km ring 1989 (mill.$)	Aggregate household income between 200 and 300 km radii from county centroid	1990 Census, Authors' est.	73681.00	74018.80
Agg hh inc within 300-400 km ring 1989 (mill.$)	Aggregate household income between 300 and 400 km radii from county centroid	1990 Census, Authors' est.	95508.52	83471.57
Agg hh inc within 400-500 km ring 1989 (mill.$)	Aggregate household income between 400 and 500 km radii from county centroid	1990 Census, Authors' est.	112480.84	92163.98
Industry-mix emp growth 1990-2000	Industry mix employment growth, calculated by multiplying each industry's national employment growth (between 1990 and 2000) by the initial period (1990) industry employ. shares in each sector	1990, 2000 BEA, Authors' est.	0.16	0.04
Population/Scale 1990				
County pop 1990	County population 1990	1990 Census	81806.94	268955.04
Pop of nearest/actual urban center 1990	1990 Population of the nearest/actual urban center measured as a micropolitan or metropolitan area	Authors' est.	375588.83	1381874.52
Demography 1990				
% African American 1990	% of 1990 population African-American	1990 Census	8.60	14.32
% Native American 1990	% of 1990 population that are Native American	1990 Census	1.44	5.59
% Hispanic 1990	% of 1990 population Hispanic	1990 Census	4.37	10.96
% Asian-Pacific 1990	% of 1990 pop Asian and Pacific islands origin	1990 Census	0.59	1.26
% Other ethnicity 1990	% of 1990 pop. with other race background	1990 Census	1.80	4.57
% 7-17 years 1990	% of 1990 population 7-17 years	1990 Census	16.78	2.34
% 18-24 years 1990	% of 1990 population 18-24 years	1990 Census	9.18	3.43
% 25-54 years 1990	% of 1990 population 25-54 years	1990 Census	39.74	3.71
% 55-59 years 1990	% of 1990 population 55-59 years	1990 Census	4.56	0.73
% 60-64 years 1990	% of 1990 population 60-64 years	1990 Census	4.70	0.98
% 65+ years 1990	% of 1990 population 65 years and over	1990 Census	14.97	4.33
% High school grad 1990	% of 1990 population 25 years and over that are high school graduates	1990 Census	34.36	6.12
% with some college 1990	% of 1990 population 25 years and over that have some college education	1990 Census	16.39	4.50
% with associate degree 1990	% of 1990 population 25 years and over that have an associate degree	1990 Census	5.34	2.10
% College grad 1990	% of 1990 population 25 years and over that are 4-year college graduates	1990 Census	13.43	6.45
% Female 1990	% of 1990 population that are female	1990 Census	51.02	1.61
% Married 1990	% of 1990 population that are married	1990 Census	59.12	6.23
% with disabilities 1990	% of 1990 16-64 pop with a work disability	1990 Census	9.55	2.89
House characteristics 1990				
House age 1990	Age of housing unit in 1990 (years)	1990 Census	26.04	9.57
Share 1 bedroom 1990	Share of 1 bedroom house to total rooms 1990	1990 Census	0.09	0.04
Share 2 bedroom 1990	Share of 2 bedroom house to total rooms 1990	1990 Census	0.32	0.05
Share 3 bedroom 1990	Share of 3 bedroom house to total rooms 1990	1990 Census	0.43	0.06
Share 4 bedroom 1990	Share of 4 bedroom house to total rooms 1990	1990 Census	0.12	0.04
Share 5 bedroom 1990	Share of 5 bedroom house to total rooms 1990	1990 Census	0.03	0.02
Share mobile homes 1990	Share of mobile units to all housing units 1990	1990 Census	0.14	0.08
Share complete plumb 1990	Share with complete plumbing facility 1990	1990 Census	0.97	0.03
Share complete kitchen 1990	Share with complete kitchen facility 1990	1990 Census	0.98	0.02
Number of counties			**3028**	

Notes: The metropolitan/micropolitan definitions follow from the 2003 definitions. ERS, USDA = Economic Research Services, U.S. Department of Agriculture; BEA, REIS = Bureau of Economic Analysis, Regional Economic Information System. C-RERL = Canada Rural Economy Research Lab, University of Saskatchewan.

Appendix Table 2: Mean and Standard Deviations (in parentheses) of Major Variables by Population Group

Variables	Non-metro	Small MA≤ 250k	Large MA>250k
Dependent variables:			
log(av wage 2000) – log(av wage 1990)	0.34	0.35	0.37
	(0.09)	(0.07)	(0.09)
log(wtd av med rent 2000) – log(wtd av med rent 1990)	0.44	0.45	0.41
	(0.14)	(0.13)	(0.17)
Cohort 25-29 share change over 1990-2000	-1.85	-1.35	-0.88
	(1.42)	(1.13)	(1.52)
Cohort 30-34 share change over 1990-2000	-0.95	-1.16	-1.06
	(0.89)	(0.93)	(0.82)
Cohort 35-39 share change over 1990-2000	-0.28	-0.42	-0.45
	(0.94)	(0.81)	(0.73)
Cohort 40-49 share change over 1990-2000	0.00	-0.86	-1.23
	(1.42)	(1.27)	(1.48)
Cohort 50-59 share change over 1990-2000	-0.19	-1.13	-1.76
	(1.28)	(1.05)	(1.29)
Cohort 60-69 share change over 1990-2000	-0.41	-1.22	-1.63
	(1.30)	(1.08)	(1.07)
Cohort 70-79 share change over 1990-2000	-2.49	-2.54	-2.57
	(1.06)	(0.75)	(0.65)
Cohort 80 + share change over 1990-2000	-6.96	-5.63	-5.04
	(1.97)	(1.66)	(1.70)
College grad share change over 1990-2000	2.57	3.18	4.22
	(1.93)	(2.10)	(2.26)
Distance variables:			
Dist to the nearest urban center	41.07	n.a.	n.a.
	(36.52)		
Dist to the center of own metro	n.a.	17.76	28.60
		(18.61)	(19.52)
Incremental distance to a MA	55.40	n.a.	n.a.
	(51.67)		
Incremental distance to MA>250,000	66.80	93.23	n.a.
	(106.20)	(93.26)	
Incremental distance to MA>500,000	42.89	36.89	36.29
	(66.07)	(59.07)	(73.34)
Incremental distance to MA>1,500,000	89.03	78.54	99.37
	(111.10)	(115.44)	(139.88)
No. of counties	1972	416	640

Notes: The categories are determined using 2003 micropolitan and metropolitan area definitions. See the text for more details.